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State of California

The Resources Agency

THE CALIFORNIA DROUGHT - 1976

May 1976

Department of Water Resources

FOREWORD

On February 1, the Department issued a special report on dry-year impacts in California, as concern grew over the lack of rain and snow throughout most of the State during the current water year. In the months since that report, the very dry conditions have continued. We now expect 1976 to be the third driest year of record in most of the State and, clearly, the driest year of the modern era.

Many water projects in the State have been developed to regulate the highly variable rainfall and runoff and, in most cases, these projects are providing adequate supplies this year. However, this year is so extremely dry that while most water systems are meeting the demand, many systems are being severely tested and some have been found lacking.

In many respects, this year is the most severe test of our water management abilities. Traditionally, projects have been formulated to operate through dry periods, but our experience now is showing vividly the difference between such theories and the realities of operating complex systems in the midst of the myriad of economic, social, and environmental counterforces which we see today. These pressures have caused several water agencies to take greater risks in the use of water this dry year than were intended in the design of their projects.

Of particular concern is the need to protect the Sacramento-San Joaquin Delta, through which vast quantities of water must pass and which is subject to specific protection under California law. This protection is presently being provided cooperatively by the state and federal governments.

In this report, the Department summarizes information on water supply, current impacts, and expected impacts during the remainder of the year. It also discusses some possible strategies which may be employed to ease 1976 impacts, as well as those which would occur in 1977, should next winter again provide less than a normal supply.

The large number of water agencies which have been required to impose tough conservation measures this year demonstrates the usefulness and practicality of saving water and limiting waste. The Department encourages utility managers and consumers alike to recognize the finite nature of our resources and make water conservation an ongoing effort. This will extend the life of existing water projects, save energy, and minimize adverse environmental impacts.

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THE STATEWIDE WATER PICTURE

With 100 years of record in hand, television weather reporters and the Chamber of Commerce are prepared to prove that California has the greatest climate in the world. But when the flooding rains descend or the rains simply bypass California, such events are described as "exceptional". California does indeed have an exceptional climate - and many exceptional years. The dry year, 1976, is such a year.

Prior to the construction of large storage reservoirs, Central and Southern California had been about equally affected by floods and droughts. Early newspaper accounts document the floods of 1815-1825, followed by a drought of 1827-29, and floods of 1832 and 1842.

The drought of 1856-57 followed 20 years of near-normal or above-normal water supply, during which the luxúriant pastures had become overstocked. During the summer of that year, and the ensuing winter, the loss of cattle in Los Angeles County alone was estimated at 100,000 head. Following the legendary flood of 1861-62 came the drought of 1863-64, which was probably the driest of all recorded droughts in Southern California and resulted in an end to beef cattle as the main industry.

In the Sacramento River Basin, the longest sustained drought in the past 125 years was the six-year period from 1929 through 1934. The driest single year was 1924. Figure 1, "Seasonal Precipitation at Sacramento", illustrates the climatic variation facing the water user. The median and lower quartile values are shown for comparison. The median is the middle value when they are arranged in order from the smallest to largest. The lower quartile value is the value which is exceeded in 3/4 of the years. These terms are defined more fully in Appendix A.

Most of the water projects in northern California which will supply water to us this year were designed on the basis of the single driest year, 1924, or on the 1929-1934 dry period. In recent years, many studies have attempted to define the recurrence interval of that six-year drought, and the best preliminary estimate is that it could be expected to recur once in 200 years, with a range of 100 to 350 years.

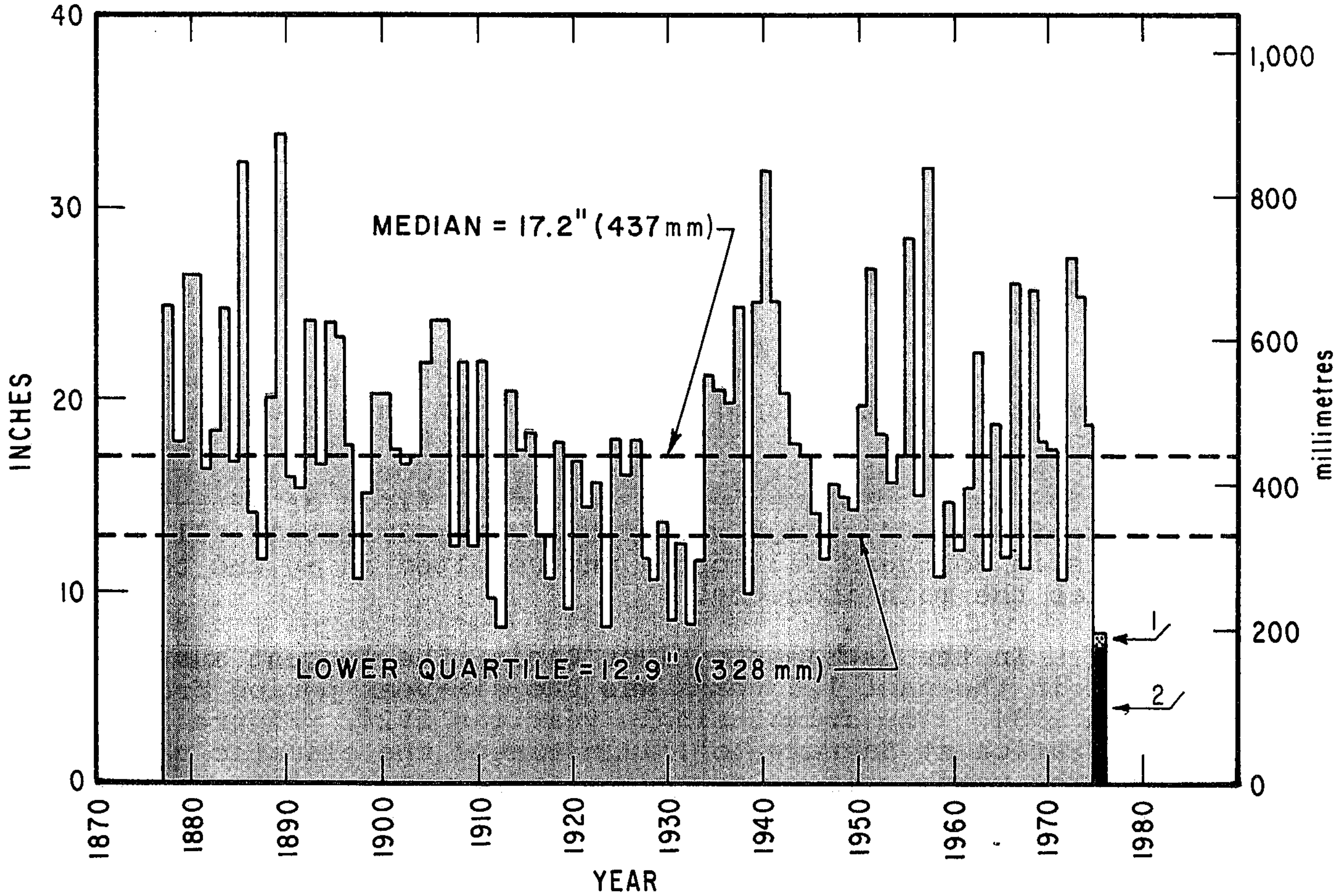
Precipitation

Precipitation in the form of rain or snow is the basic determinant of our water supply. Dry-farmed (nonirrigated) lands depend entirely on the amount and timing of rainfall for grass for grazing and for grain. Irrigated areas utilize the direct rainfall and supplement it during the growing season with additional applied water. Precipitation in the form of snow provides our late spring

FIGURE 1

SEASONAL PRECIPITATION AT SACRAMENTO

(JULY 1ST - JUNE 30TH)



1/ 1975-76: TOTAL OF OBSERVED PRECIPITATION JULY 1, 1975 THROUGH APRIL 30, 1976 AND ASSUMING NORMAL PRECIPITATION FOR MAY AND JUNE 1976, 7.88 Inches (200 mm)

2/ 1975-76: TOTAL OF OBSERVED PRECIPITATION JULY 1, 1975 THROUGH APRIL 30, 1976, 7.20 Inches (183 mm) snowmelt runoff. During the 1976 winter, the deficiency in precipitation throughout California has affected, and continues to affect, all water sources.

The cause of the precipitation deficiency was the persistence, since early November 1975, of a ridge of high atmospheric pressure near the west coast, with above-normal pressures in the surrounding area, including California. This years weather fronts, which normally bring the winter rains to the State, were either so weakened by the high pressure that moisture was lacking in the weak fronts which entered California, or the fronts which formed over the Pacific Ocean were shunted north toward the State of Oregon or even farther.

Meteorologists are asking why the high pressure was so persistent this year. They have had to conclude that they do not know. The persistent above-normal pressures in this sector of the hemisphere are related, however, to other sectors of the northern hemisphere where droughts and floods are occurring. Floods occurred in Oregon and later in the Souris River in the Midwest. England is experiencing its worst drought in 200 years.

Precipitation in California from October 1, 1975 (the start of the water year), to May 1, 1976, is depicted in Figure 2 "Seasonal Precipitation, October 1, 1975 - April 30, 1976". California experienced below-normal precipitation nearly everywhere. The most fortunate areas received 80 to 90 percent of normal rainfall, including the north coast, the San Joaquin Valley near Tulare Lakebed, and some of the mountains of Southern California. Of particular note is the very deficient area in the center of the State, encompassing the coastal area from below Monterey, through San Francisco, to above Jenner in Sonoma County, and extending inland to include most of the Sacramento Valley, the northern portion of the San Joaquin Valley to Merced, and the adjacent western front of the Sierra Nevada.

Although precipitation this year was unusual, the State has historically known many exceptional years, both high and low. Figure 3, "Long Term Precipitation at Selected Stations", presents the variation since 1921 at Eureka in the North Coastal Area, at Red Bluff in the Sacramento Valley, at Lake Spaulding at the 5,000 foot level (1 524 metres) near Interstate 80 in the Sierra Nevada, at Fresno in the San Joaquin Valley, at Los Angeles in the South Coastal Area, and at Needles in the desert. For comparison, each graph includes the amount which has occurred to date in 1976; and, since the precipitation season is substantially over, represents qualitatively the relative position of this year in the historical picture. The median and the lower quartile precipitation is also shown for comparison. The lower quartile value is the maximum which occurred in the driest 25 percent of the years shown.

FIGURE 2

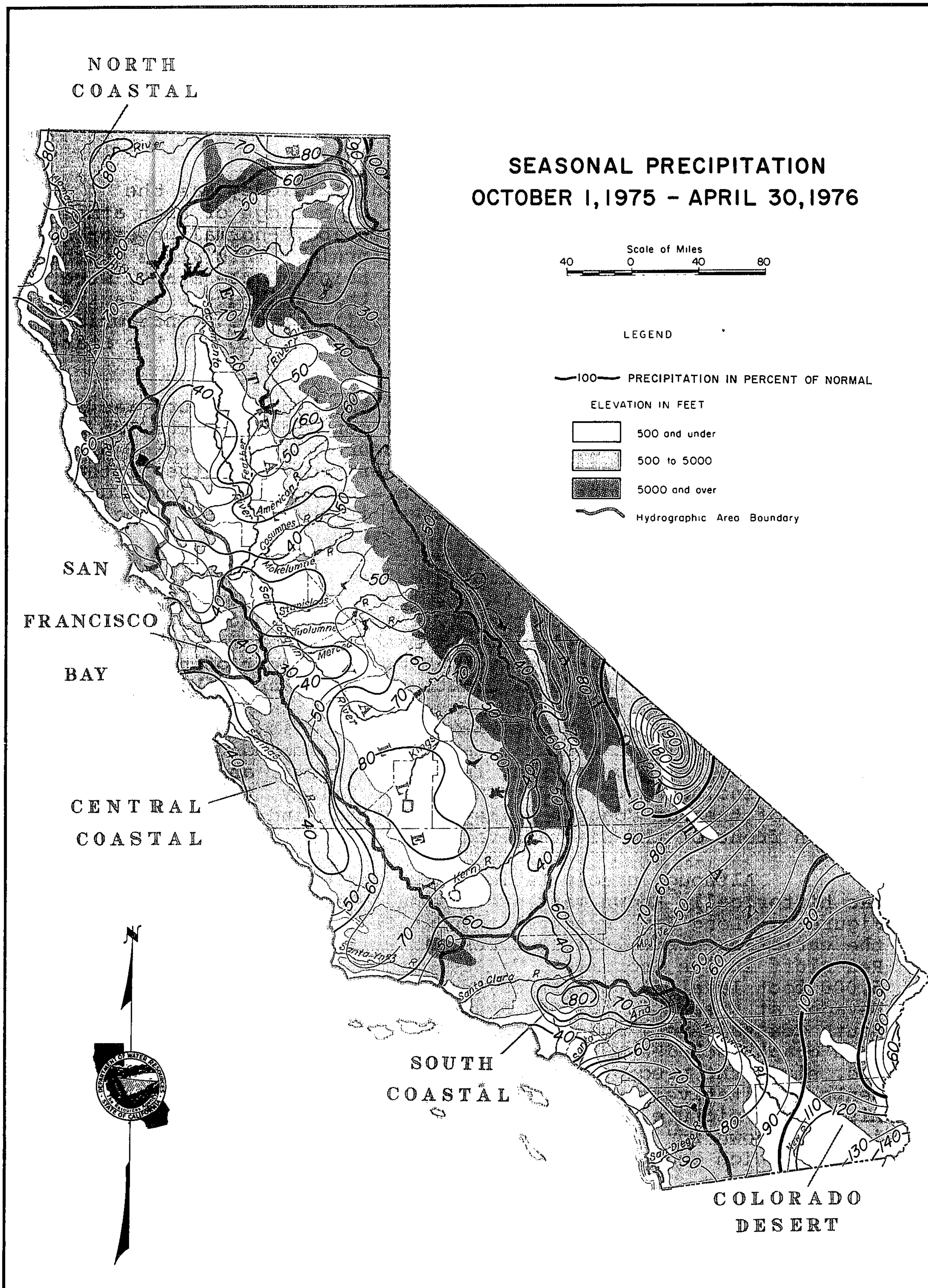

SEASONAL PRECIPITATION
OCTOBER 1, 1975 - APRIL 30, 1976
Scale of Miles
40 0 40 80
LEGEND
100 PRECIPITATION IN PERCENT OF NORMAL
ELEVATION IN FEET
500 and under
500 to 5000
5000 and over
Hydrographic Area Boundary
NORTH COASTAL
SAN FRANCISCO BAY
CENTRAL COASTAL
SOUTH COASTAL
COLORADO DESERT
Sacramento
Feather
American R
Cosumnes R
Mokelumne R
Stanislaus
Tuolumne
Merced
Kings
Kern R
Santa Clara R
San Diego
Russian
Mojave

FIGURE 3 A

LONG TERM PRECIPITATION AT SELECTED STATIONS

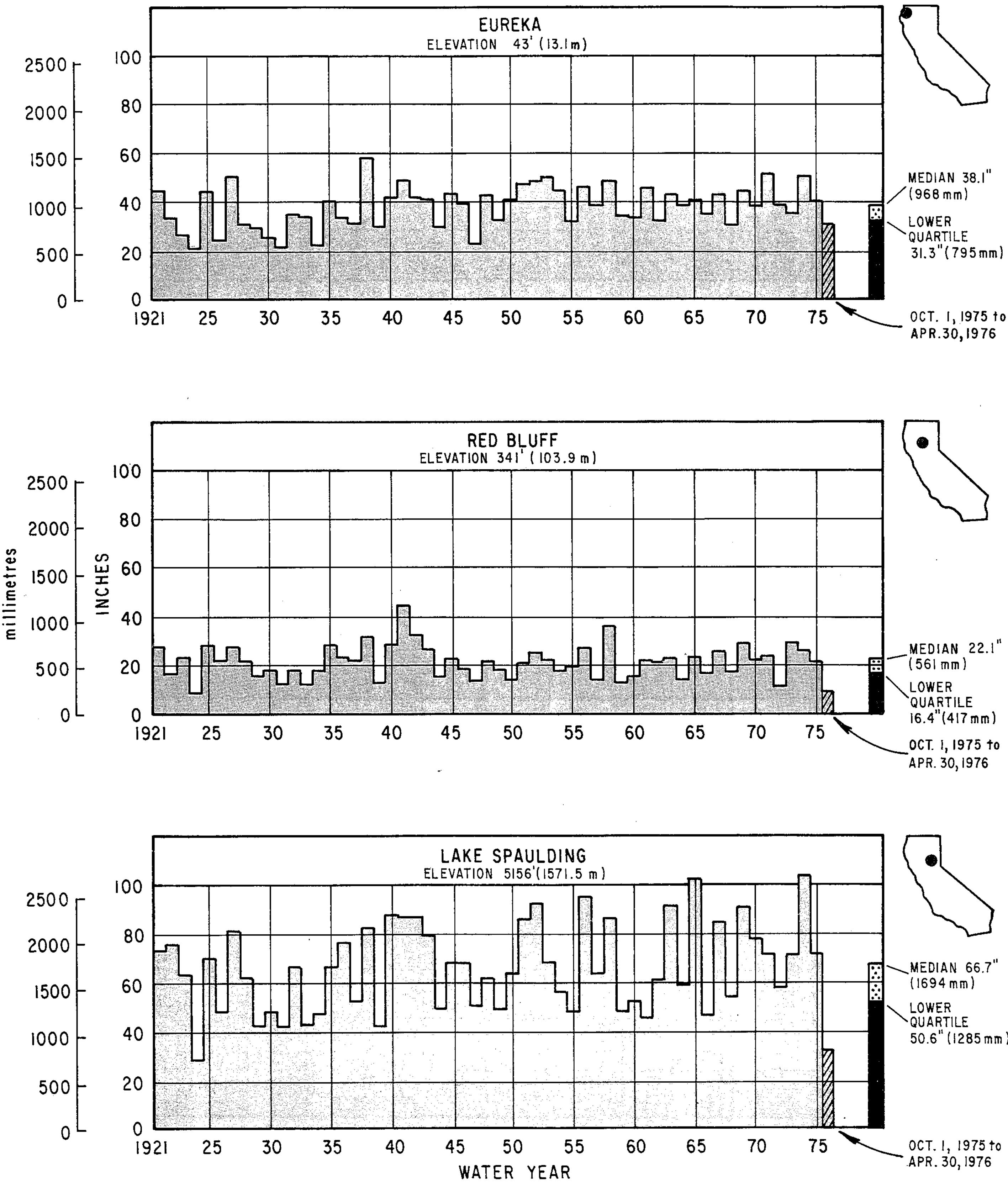


FIGURE 3 B

LONG TERM PRECIPITATION AT SELECTED STATIONS

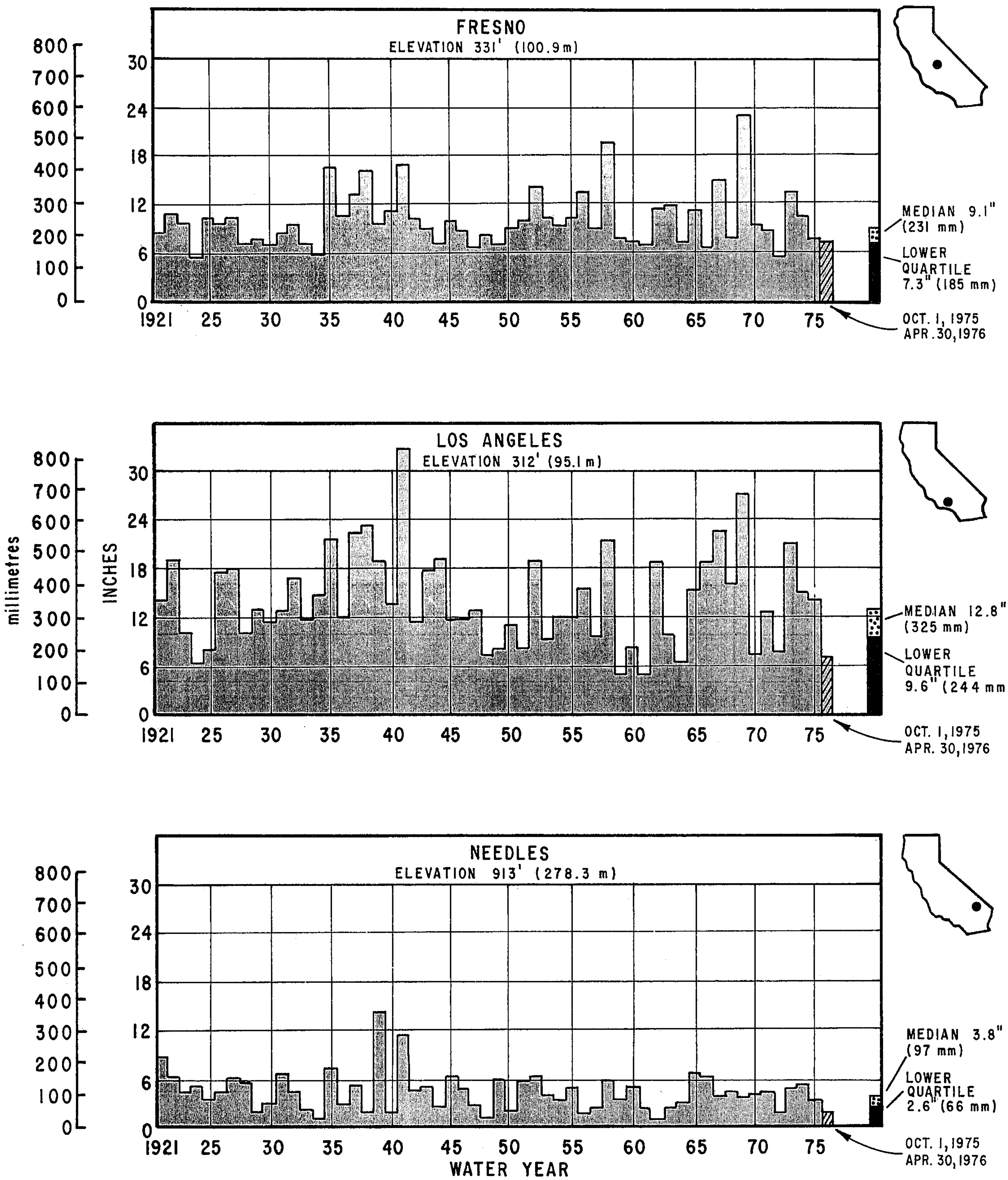


Figure 4, "Monthly Precipitation Patterns for Selected Dry Years", compares this year's pattern with normal precipitation and with the pattern in other historic dry years.

To illustrate the ranking of the present dry year with other years, a search of the precipitation records since 1900 at some stations in the State shows that this year's precipitation at San Francisco was the driest of record, with Sacramento and Bakersfield experiencing their second driest years. Rainfall at Red Bluff was the driest of record through the winter months, but 1.91 inches (49 millimetres) fell in April, making the seasonal total the fourth driest of record. At Eureka on the north coast, this year's precipitation total of 31.91 inches (811 millimetres) does not rank as an especially dry year.

In this extremely dry year, one event provided a sharp contrast. On February 8, 1976, 2.1 inches (53 millimetres) of rain fell in five minutes at Haines Canyon-Upper, a precipitation station northeast of Tujunga in the San Gabriel Mountains. This occurrence set a new intensity record for the State of California. The rainfall took place when the persistent high-pressure ridge moved northward, allowing a low-pressure cell to form off the Southern California coast bringing strong convective cloud masses and heavy shower cells into the southern part of the State.

April precipitation in California averaged about normal for the State as a whole. The north coast had about 120 percent of normal; San Diego, about 163 percent of normal; and Merced in the San Joaquin Valley, 140 percent of normal. The dry mid-State swath through San Francisco and Sacramento varied from 70 to 95 percent of normal.

Snow Accumulation

This year will go down in the books as one of the most "exceptional" in snow surveying history. Snow accumulation was less than 50 percent of normal on February 1, 1976, after the low precipitation in November, December, and January. The dry year prediction made at that time was based on the fact that 250 percent of normal February and March snowfall would have been required to bring the April 1 water content up to normal. February did not break the winter drought, and on March 1 snowpack water content was about one-half the normal seasonal accumulation.

Water supply conditions deteriorated further as March became the fourth month of below-average snow accumulation. By April 1, snowpack water content was the lowest of record at about one-third of the State's snow courses. Information provided by the remote snow sensor network in the Sierra Nevada indicated that the accumulation peak occurred about mid-March and that snowmelt was beginning.

FIGURE 4 A

MONTHLY PRECIPITATION PATTERN FOR SELECTED DRY YEARS

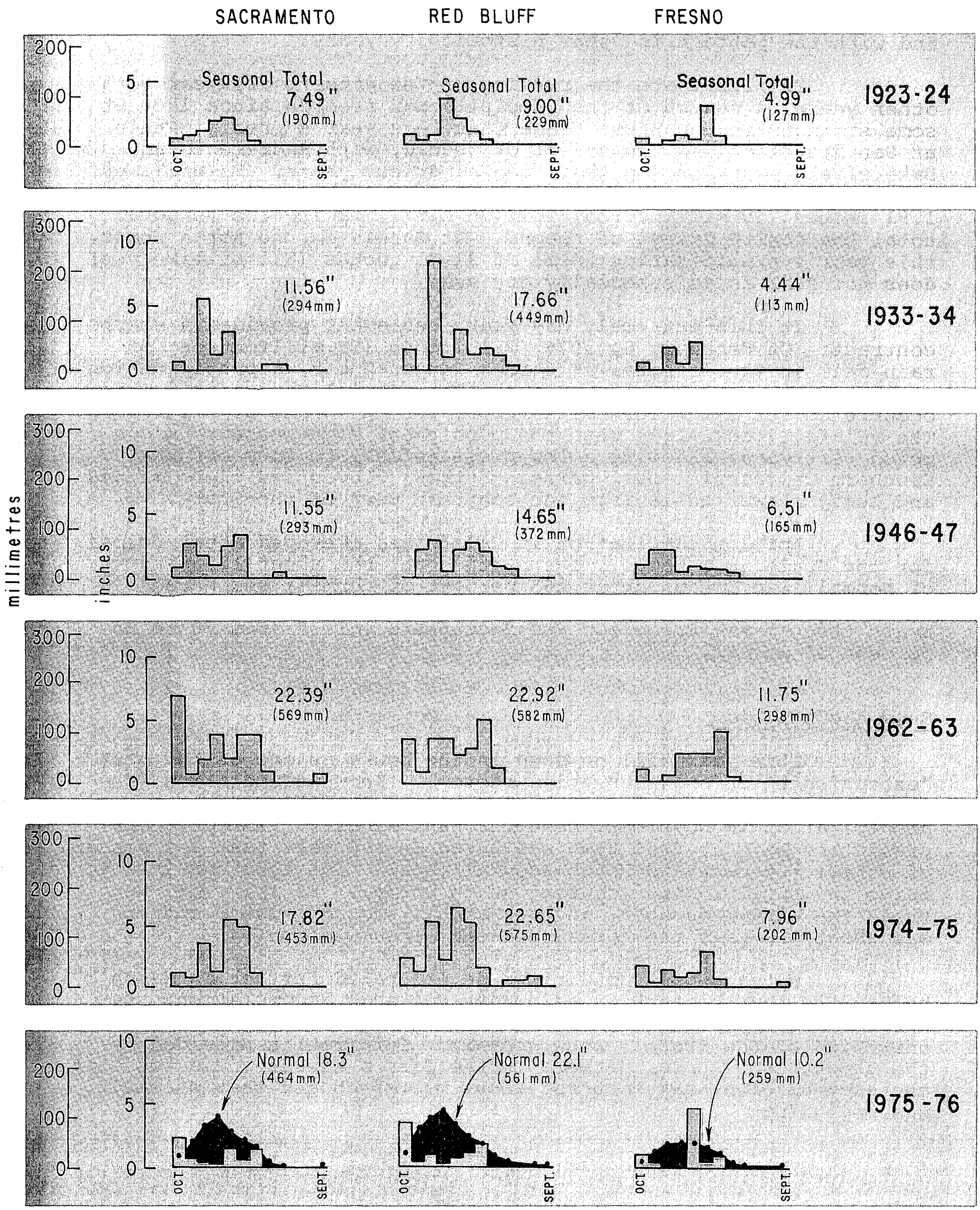
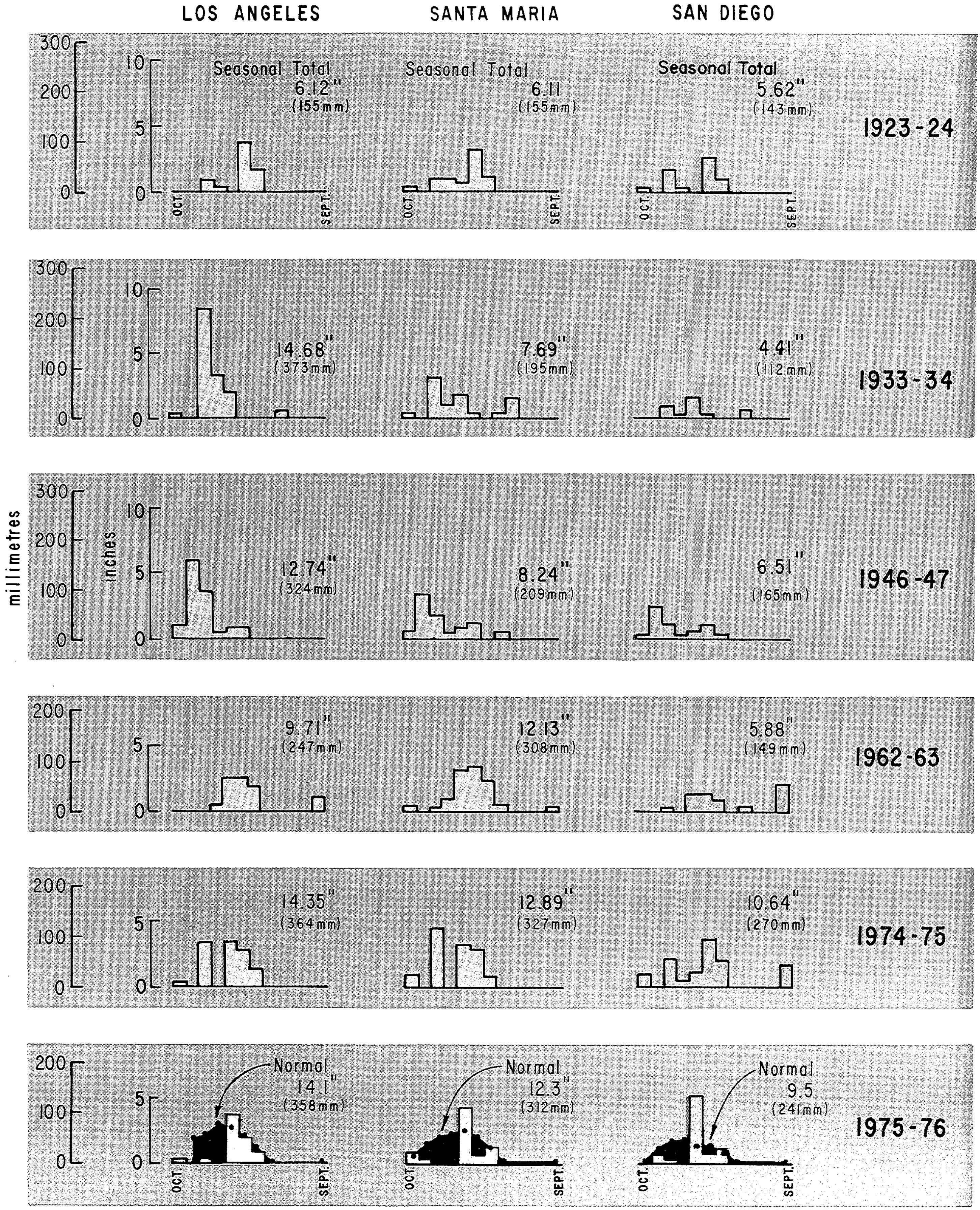


FIGURE 4 B

MONTHLY PRECIPITATION PATTERN FOR SELECTED DRY YEARS



The snowpack on May 1 throughout the State was well below normal, and in the Sierra Nevada watersheds the melting cycle was expected to be completed early. May 1 snow surveys showed that 68 of the 222 snow courses measured that month were already bare. Water content of the snow was only 40 percent of normal in the Sacramento Valley watershed and 25 percent of normal in the San Joaquin Valley watershed. Satellite imagery supplied by NASA indicated the effective snow line on May 1 averaged 8,300 feet (2 530 metres), and that the snow-covered area in the San Joaquin, Kings, Kaweah, Tule, and Kern River Basins was 2,000 square miles (5 200 square kilometres) this year, compared to 3,650 square miles (9 500 square kilometres) of snow-covered area on May 1 last year.

Figure 5, "Snowpack Accumulation - Water Content in Percent of April 1 Average", compares 1976 to two other low snowpack years, 1948 and 1963. In both of the earlier years, much above normal additional snow accumulation occurred during April, ameliorating the potential severe water supply problem. This year the situation worsened in April in all areas, except the north coast, where snowpack is not a major factor contributing to water supply.

Runoff to Date and Forecasts for 1976

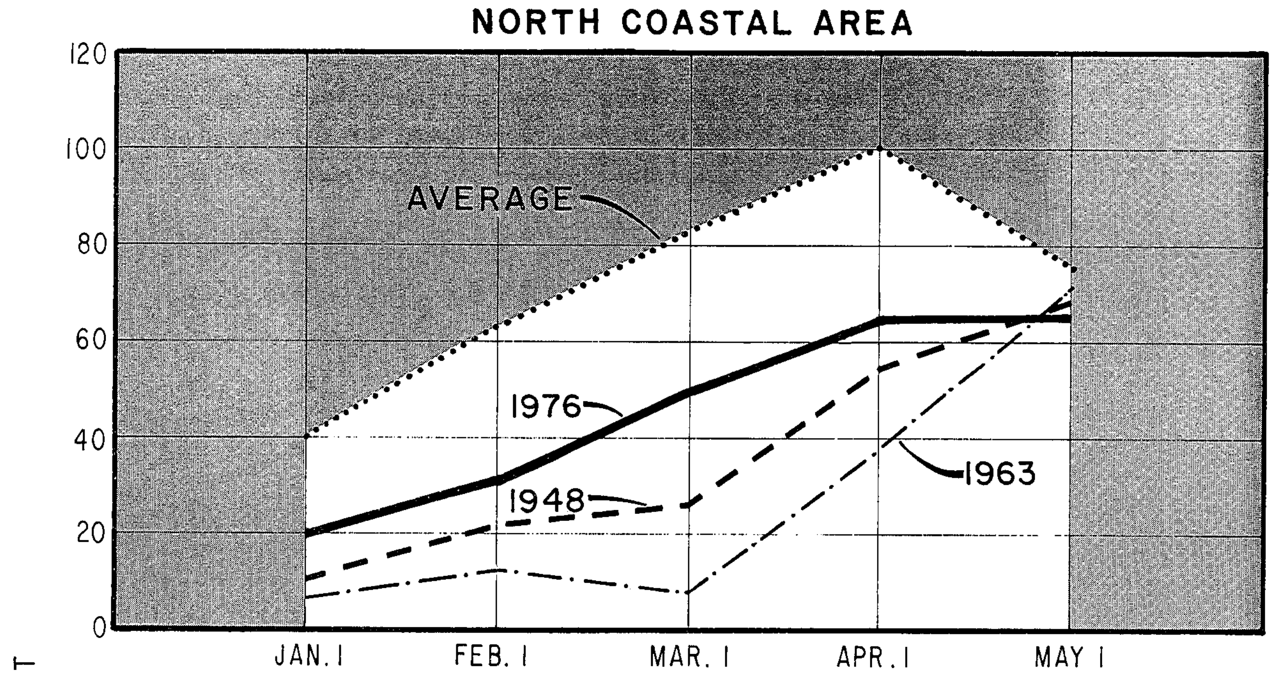
Except for October, 1975, the start of the water year, streamflows throughout the State have been below normal. By January 1976, some records for low flows were beginning to be established, such as the January runoff of 12 percent of normal for the Stanislaus River. Several small coastal streams had only 5 percent of usual January flow. Hardest hit were streams in the area from Monterey to Jenner along the coast. As of February 1, 1976, water year runoff varied from 5 percent of normal in the Bay area to 125 percent of normal in the West Walker River, with most Central Valley streams producing about 60 percent of normal.

Streamflows and runoff remained at nearly 50 percent of normal in February, with near zero streamflow in the Bay area. The picture in March remained the same. Perennial streams were predicted to recede to base flow early in the year and intermittent streams were expected to cease flowing much earlier in the year than usual.

Runoff during April was about 45 percent of normal, ranging from less than 10 percent of normal in San Francisco Bay area streams to a high of 60 percent of normal for the North Coastal area streams. In the Central Valley, runoff was 38 percent of normal, with only the Sacramento River exceeding 50 percent of normal for the month. Runoff since October 1, 1975, has averaged 45 percent of normal in the Central Valley and is not expected to exceed 50 percent of normal by September 30, 1976, the end of the water year.

FIGURE 5 A

SNOWPACK ACCUMULATION WATER CONTENT IN PERCENT OF APRIL 1 AVERAGE



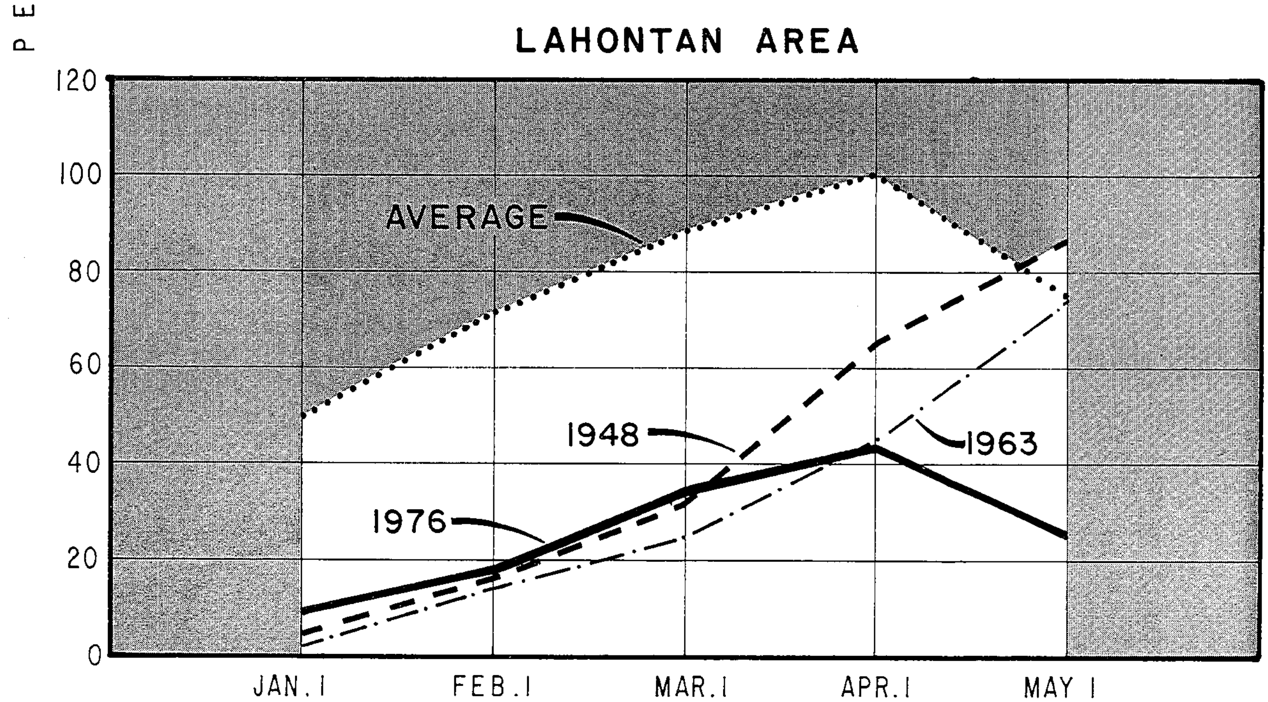
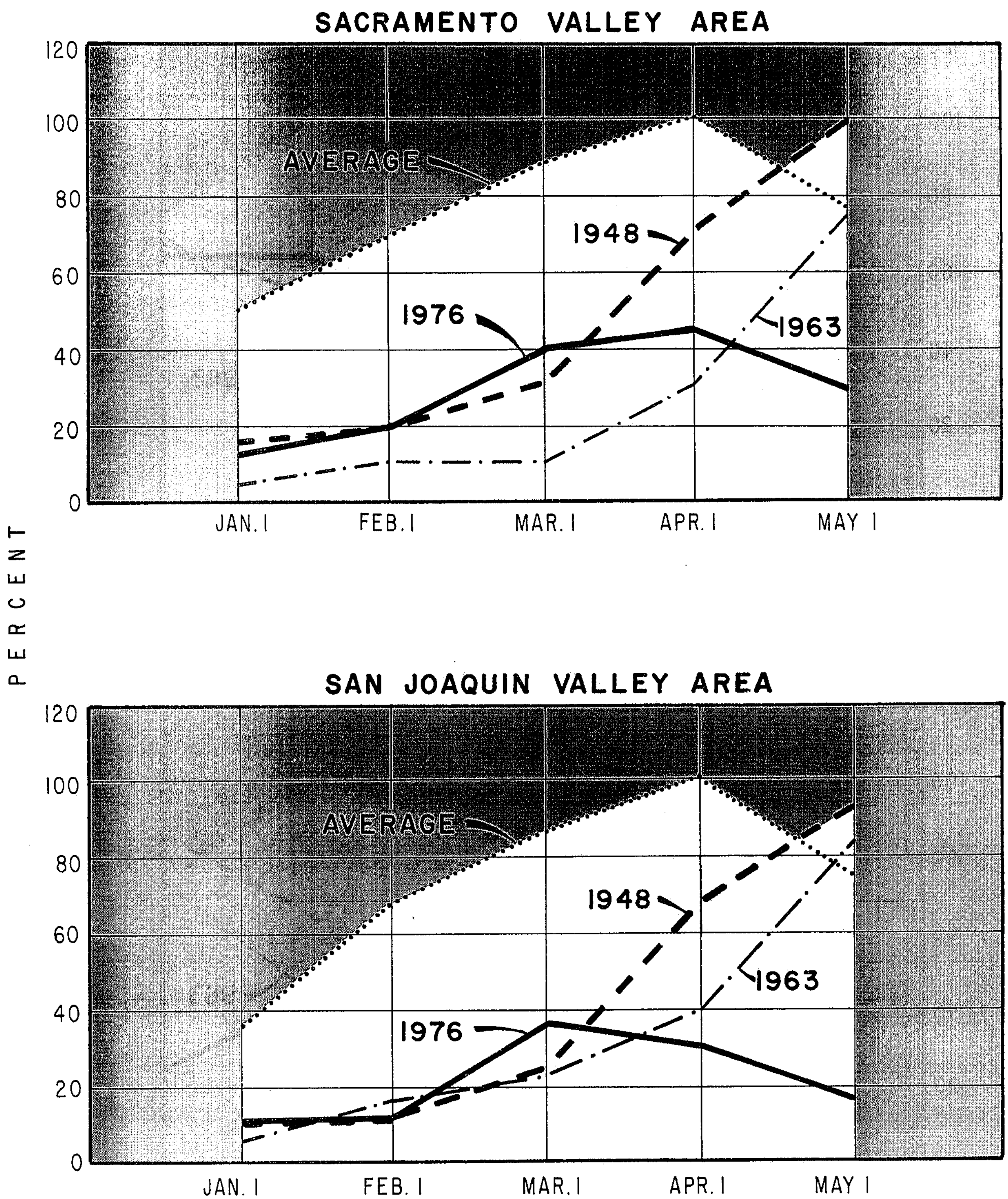


FIGURE 5 B

SNOWPACK ACCUMULATION WATER CONTENT IN PERCENT OF APRIL 1 AVERAGE



Pine Creek, the major source of inflow to Eagle Lake in Lassen County has had no measurable flow so far this year and none is expected to occur. The Susan River on April 21, 1976, was flowing at 45 cubic feet per second (13 cubic metres per second), compared to an average over the past 10 years on that date of 247 cubic feet per second (7.0 cubic metres per second).

The driest area near the center of the State produced some unusually low streamflows in March and April. A comparison of 1976 flows with 1975 flows in some typical small streams follows:

Stream	Approximate Date	Flow, 1976 Cubic feet per second	Flow, 1976 Cubic metres per second	Flow, 1975 Cubic feet per second	Flow, 1975 Cubic metres per second
Bear Creek near Lodi	3/26	0.7	.02	110	3.11
Bear Creek near Rumsey	3/26	2.4	.07	119	3.37
Deer Creek near Sloughhouse	4/23	1.9	.05	14	0.40
Dry Creek at Roseville	3/11	29.8	.84	133	3.77
Pope Creek near Pope Valley	3/26	3.1	.09	485	13.73
Squirrel Creek	3/25	13.7	.39	172	4.87
Sutter Creek	4/22	5.8	.16	62	1.76

Forecasts of unimpaired[a/] April-July and water year inflow to many reservoirs of the State are prepared each month, beginning in February. These forecasts are based on flow to date, expected runoff from snowpack already on the ground, and an assumption of normal precipitation thereafter.

Forecasts of reservoir inflow made on May 1, 1976, demonstrate that the 1976 flows parallel those which would have occurred in 1924 (the driest single year of record), had today's reservoirs existed then. Flows for the two years are shown in Table 1, "Comparison of April-July 1976 Runoff Forecasts to 1924 Flows". While the inflows to the Shasta and Oroville reservoirs are somewhat higher than the 1924 values, an almost exact parallel exists between 1976 and 1924 from the Yuba River Watershed southward through the San Joaquin River Watershed. New record low amounts of runoff for April through July are expected on the

a/ See Appendix A for definition.

TABLE 1

Comparison of April-July 1976 Unimpaired Runoff Forecasts to Historical 1924 Flows, in Percent of Average

Forecast Point	April-July forecast	1924 Flows
Inflow to Shasta	77	41
Feather-Oroville	33	21
Yuba-Smartville	23	22
American-Folsom	19	19
Cosumnes-Michigan Bar	15	9
Mokelumne-Pardee	26	27
Stanislaus-Melones	20	23
Tuolumne-Don Pedro	28	31
Merced-Exchequer	28	29
San Joaquin-Millerton	28	29
Kings-Pine Flat	32	24
Kaweah-Terminus	30	26
Tule-Success	20	(1934) 4
Kern-Isabella	26	(1961) 20

American, Mokelumne, Stanislaus, Tuolumne, and Merced Rivers. From the Kings River watershed on the north through the Kern River watershed near Bakersfield on the south, expected April-July flows this year are about 5 to 15 percent higher than the lowest flow of record.

Since the precipitation season is essentially ended by May 1, estimates of the water year runoff of most streams can be made. Table 2, "Streamflow Data for Selected Streams,1976" presents this information for representative streams throughout the State. The flow to date is shown along with the projected water year flow (flow to date plus forecast flow through September 30, 1976). For comparison, the water year median flow and the lower quartile flow are also shown. The lower quartile flow is obtained by ranking all the flows of record and selecting that flow for which 25 percent of the flows are lower.

Of particular note are the very low flow values for the Russian River at Healdsburg (16 percent of average) and the San Francisco Bay area and Central Coastal area streams, which range from 0 to 10 percent of average. These streams are located in the notably dry zone through the central part of the State.

Current Status of Reservoirs

Table 3, "Storage in Major Reservoirs at end of April 1976, and comparison with Dry Years 1947 and 1961", presents actual water in storage and the percent of average for the last 10 years. End of April storage values are compared to values for 1947 and 1963. Most reservoirs were near their seasonal high on May 1, since much of the snowmelt had already occurred and deliveries of water to users had begun. A discussion of the strategies of reservoir operation later in this report includes an indication of the expected reservoir stages through the summer. More exact information is also presented later under "Recreation" in Table 5.

The figures in Table 3 indicate that May 1 reservoir storage in the Central Valley was 83 percent of normal and San Joaquin Valley reservoirs were 95 percent of normal. The Sacramento Valley reservoirs were 77 percent of normal. Although the figures in Table 3 are not startling in themselves, the low values of inflow forecast, which are caused by the low snowpack, indicate a serious situation in some areas.

Ground Water Levels

In the North Coastal Area of California, all ground water levels this year are lower than those in the spring of 1975 and, in some cases, are even lower than those in the fall of 1975. Near the coast, ground water levels, compared to the spring of 1975, are down about 1 foot (0.3 metre); inland basins are down as

Table 2

Streamflow Data for Selected Streams, 1976
(Unimpaired flows in 1,000 acre-feet)*

Area, Stream, and Station	Flow to Date (Oct-Apr)	% of avg.	Projected Water Year Flow	% of avg.	Water Year Median Flow	Water Year Lower Quar. Flow
North Coastal Area						
Klamath, Copco to Orleans	2,443	75	3,325	75	4,295	3,360
Salmon at Somesbar	708	82	975	80	1,180	960
Trinity at Lewiston	406	50	725	59	1,085	800
Eel at Scotia	2,590	52	2,680	50	4,720	3,550
Russian at Healdsburg	120	16	125	16	771	557
San Francisco Bay Area						
Napa near St. Helena	3	5	3.5	5	52	31
Coyote Creek near Madrone	0	0	0	0	32	12
Central Coastal Area						
Arroyo Seco near Soledad	10	10	11	10	89	47
Nacimiento below Nacimiento Dam	13	7	14	7	141	74
South Coastal Area						
Sespe Creek near Fillmore	22	31	24	31	38	19
Arroyo Seco near Pasadena	1.8	30	2	30	3	1.5
Santa Ana near Mentone	16	38	20	36	45	26
Sacramento Valley Area						
Inflow to Shasta	2,394	60	3,500**	68	5,073	4,062
Sacramento above Bend Bridge	3,293	55	4,985	63	7,462	5,914
Feather, Inflow to Oroville	1,257	42	1,900**	41	3,952	2,700**
Yuba at Smartville	507	33	635	28	2,321	1,533
American, Inflow to Folsom	588	35	700	27	2,594	1,549
Cosumnes at Michigan Bar	47	16	57	16	331	166
Mokelumne, Inflow to Pardee	151	42	230	33	727	458

*1,000 acre-feet equal 1.233 x 10^{-3} cubic kilometres.
**Estimated actual inflow.

Table 2 (Continued)

Streamflow Data for Selected Streams, 1976
(Unimpaired flows in 1,000 acre-feet)*

Area, Stream, and Station	Flow to Date (Oct-Apr)	% of avg.	Projected Water Year Flow	% of avg.	Water Year Median Flow	Water Year Lower Quar. Flow
<u>San Joaquin Valley Area</u>						
Stanislaus, Inflow to Melones	235	43	305	28	1,117	692
Tuolumne, Inflow to Don Pedro	368	43	635	35	1,832	1,202
Merced, Inflow to Exchequer	166	37	290	32	919	593
San Joaquin, Inflow to Millerton	302	47	580	35	1,679	1,161
Kings, Inflow to Pine Flat	245	44	570	36	1,542	1,036
Kaweah, Inflow to Terminus	80	43	140	35	352	247
Tule, Inflow to Success	35	36	40	30	91	61
Kern, Inflow to Isabella	122	48	220	35	528	349
<u>Lahontan Area</u>						
Truckee, Tahoe to Farad	80	47	175	46	387	259
West Carson at Woodfords	18	67	30	43	76	51
East Carson near Gardnerville	57	64	107	43	238	166
West Walker below Coleville	32	80	83	47	178	127
East Walker near Bridgeport	33	77	45	42	98	65
Owens below Long Valley Dam	66	89	90	63	147	122
Colorado, Inflow to Lake Powell	3,175	87	11,000	97	11,545	8,943

TABLE 3

STORAGE IN MAJOR RESERVOIRS AT END OF APRIL 1976 AND COMPARISON WITH DRY YEARS 1947 & 1961

AREA AND DRAINAGE BASIN	RESERVOIR	OPERATOR	CAPACITY (1) ACRE-FEET	STORAGE AT END OF APRIL (ACRE-FEET) 10-YEAR AVERAGE 1966-1975	1947	1961	1976	PERCENT OF AVERAGE
NORTH COASTAL AREA								
KLAMATH RIVER	UPPER KLAMATH(2)	US BUREAU RECLAMATION	584,000	464,000	422,200	510,000	467,800	101
KLAMATH RIVER	CLEAR LAKE(2)	US BUREAU RECLAMATION	526,800	343,100	234,100	132,300	313,400	91
TRINITY RIVER	CLAIR ENGLE	US BUREAU RECLAMATION	2,448,000	2,258,700	(8)	602,300	1,955,900	87
RUSSIAN RIVER	LAKE MENDOCINO	US CORPS OF ENGINEERS	122,500	84,600	(8)	72,700	84,900	100
SAN FRANCISCO BAY AREA								
CALAVERAS CREEK	CALAVERAS(3)	CITY-CO SAN FRANCISCO	100,000	76,200	41,000	49,200	46,700	61
CENTRAL COASTAL AREA								
SAN ANTONIO RIVER	SAN ANTONIO	MONTEREY CO FCWCD	350,000	238,300(6)	(8)	(8)	278,300	116
NACIMIENTO RIVER	NACIMIENTO	MONTEREY CO FCWCD	350,000	227,100	(8)	34,600	179,900	79
SANTA YNEZ RIVER	CACHUMA	US BUREAU RECLAMATION	204,900	193,200	(8)	153,600	170,500	88
SOUTH COASTAL AREA								
COYOTE CREEK	CASITAS	CASITAS MUNICIPAL WD	254,000	189,800	(8)	4,800	216,500	114
PIRU CREEK	LAKE PIRU	UNITED WATER CON DIST	101,200	54,100	(8)	1,800	16,100	30
PIRU CREEK	PYRAMID(3)	CALIF DEPT WATER RES	171,200	166,600(5)	(8)	(8)	166,600	100
CASTAIC CREEK	CASTAIC(3)	CALIF DEPT WATER RES	323,700	283,300(5)	(8)	(8)	283,300	100
--	PERRIS(3)	CALIF DEPT WATER RES	131,500	93,000(5)	(8)	(8)	93,000	100
TRIB CAJALCO CREEK	LAKE MATHEWS(4)	METROPOLITAN WATER DIST	182,000	168,400	(9)	111,000	83,000	49
SAN JACINTO RIVER	LAKE ELSINORE	CALIF DEPT PARKS AND REC	125,000	(9)	41,200	0	11,700	--
SAN LUIS REY RIVER	HENSHAW	VISTA IRRIGATION DIST	203,600	16,000	(9)	3,100	5,200	33
SAN DIEGO RIVER	EL CAPITAN(3)	CITY OF SAN DIEGO	116,500	31,200	29,300	12,000	11,900	38
CENTRAL VALLEY AREA								
SACRAMENTO RIVER	SHASTA	US BUREAU RECLAMATION	4,552,000	4,343,900	3,091,000	3,714,300	3,013,700	69
CLEAR CREEK	WHISKEYTOWN	US BUREAU RECLAMATION	241,100	227,900	(8)	(8)	238,200	105
N FK FEATHER RIVER	LAKE ALMANOR	PAC GAS AND ELEC CO	1,308,000	839,200	595,600	443,900	581,700	69
BUCKS CREEK	BUCKS LAKE	PAC GAS AND ELEC CO	103,000	65,900	97,200	59,400	47,400	72
FEATHER RIVER	OROVILLE	CALIF DEPT WATER RES	3,537,600	3,009,200(6)	(8)	(8)	2,751,500	90
NORTH YUBA RIVER	NEW BULLARDS BAR	YUBA CO WATER AGENCY	961,300	682,000(6)	(8)	(8)	388,200	56
SOUTH YUBA RIVER	SPAULDING SYSTEM	PAC GAS AND ELEC CO	137,400	63,100	105,100	94,200	51,400	81
BEAR RIVER	CAMP FAR WEST	SO SUTTER WATER DIST	103,000	104,300	(8)	(8)	95,400	91
M FK AMERICAN RIVER	FRENCH MEADOWS	PLACER CO WATER AGENCY	133,700	85,500	(8)	(8)	49,500	58
RUBICON RIVER	HELL HOLE	PLACER CO WATER AGENCY	208,400	121,100(6)	(8)	(8)	112,500	93
SILVER CREEK	UNION VALLEY	SACRAMENTO MUN UD	271,000	185,100	(8)	(8)	131,800	71
AMERICAN RIVER	FOLSOM	US BUREAU RECLAMATION	1,010,300	737,800	(8)	701,400	636,000	86
STONY CREEK	BLACK BUTTE	US CORPS OF ENGINEERS	160,000	109,600	(8)	(8)	56,900	52
CACHE CREEK	CLEAR LAKE	YOLO COUNTY FCWCD	420,000	290,700	142,600	296,500	89,800	31
PUTAH CREEK	LAKE BERRYESSA	US BUREAU RECLAMATION	1,600,000	1,581,500	(8)	1,129,700	1,277,800	81
N FK MOKELUMNE RIVER	SALT SPRINGS	PAC GAS AND ELEC CO	139,400	54,200	61,300	42,600	24,600	45
MOKELUMNE RIVER	PARDEE	EAST BAY MUN UD	210,000	186,300	171,100	153,300	165,400	89
MOKELUMNE RIVER	CAMANCHE	EAST BAY MUN UD	431,500	290,500	(8)	(8)	275,200	95
CALAVERAS RIVER	NEW HOGAN	US CORPS OF ENGINEERS	325,000	201,500	(8)	(8)	129,100	64
STANISLAUS RIVER	MELONES	PAC GAS AND ELEC CO	112,600	71,500	112,600	67,200	55,800	78
CHERRY CREEK	CHERRY LAKE	CITY-CO SAN FRANCISCO	268,800	114,200	(8)	50,100	121,900	107
TUOLUMNE RIVER	HETCH HETCHY	CITY-CO SAN FRANCISCO	360,400	129,900	117,200	71,000	122,800	95
TUOLUMNE RIVER	DON PEDRO	TURLOCK-MODESTO ID	2,030,000	976,700(6)	(8)	(8)	1,164,700	118
MERCED RIVER	LAKE MCCLURE	MERCED IRRIG DISTRICT	1,026,000	651,500(6)	(8)	(8)	574,700	88
SAN JOAQUIN RIVER	MAMMOTH POOL	SO CALIFORNIA EDISON CO	122,700	31,100	(8)	12,400	18,800	60
MONO CREEK	THOMAS A EDISON	SO CALIFORNIA EDISON CO	125,000	34,900	(8)	26,300	30,300	87
STEVENSON CREEK	SHAVER LAKE	SO CALIFORNIA EDISON CO	135,300	37,500	12,500	21,900	45,700	122
SAN JOAQUIN RIVER	MILLERTON LAKE	US BUREAU RECLAMATION	520,600	364,300	331,400	277,500	381,000	105
SAN LUIS CREEK	SAN LUIS(3)	US BUREAU REC-CALIF DWR	2,038,800	1,989,300(6)	(8)	(8)	1,859,700	92
HELMS CREEK	COURTRIGHT	PAC GAS AND ELEC CO	123,300	49,200	(8)	43,900	54,400	111
N FK KINGS RIVER	WISHON	PAC GAS AND ELEC CO	128,000	30,800	(8)	43,500	26,700	87
KINGS RIVER	PINE FLAT	US CORPS OF ENGINEERS	1,001,500	667,500	(8)	342,900	547,000	82
KAWEAH RIVER	TERMINUS	US CORPS OF ENGINEERS	150,000	54,300	(8)	(8)	45,200	83
KERN RIVER	ISABELLA	US CORPS OF ENGINEERS	570,000	206,700	(8)	35,000	155,900	75
LAHONTAN AREA								
LITTLE TRUCKEE RIVER	STAMPEDE(2)	US BUREAU RECLAMATION	226,500	144,700(6)	(8)	(8)	124,200	85
TRUCKEE RIVER	LAKE TAHOE(2,7)	US BUREAU RECLAMATION	744,600	585,800	552,500	125,100	469,700	80
OWENS RIVER	LAKE CROWLEY	LOS ANGELES DEPT WP	183,500	139,500	132,400	99,400	121,400	87
COLORADO DESERT AREA								
COLORADO RIVER	LAKE POWELL(2,7)	US BUREAU RECLAMATION	25,002,000	11,377,600	(8)	(8)	19,664,000	173
COLORADO RIVER	LAKE MEAD(2,7)	US BUREAU RECLAMATION	26,102,000	16,859,300	16,283,000	17,898,000	20,099,000	119
COLORADO RIVER	LAKE MOHAVE(2,7)	US BUREAU RECLAMATION	1,810,000	1,651,100	(8)	1,734,000	1,655,500	100
COLORADO RIVER	LAKE HAVASU(2,7)	US BUREAU RECLAMATION	619,000	595,300	657,600	448,700	588,900	99

(1) Total capacity to nearest hundred acre-feet.
(2) Interstate reservoir used jointly by California and adjacent states.
(3) Includes foreign water.
(4) Stores only imported Colorado River water.
(5) New reservoir -- average considered equal to current storage.
(6) Less than 10-year average.
(7) Data based on active or usable capacity tables.
(8) Reservoir not in existence.
(9) Data not available.

much as 2.5 feet (0.8 metre). In the northeastern portion of the State, ground water levels are lower this spring than in the spring of 1975 by about 1.5 feet (0.5 metre). In Lassen County, three dug wells, each less than 50 feet (15 metres) deep are already dry. Deeper wells, whose water levels are near last fall's water levels, are experiencing lower yields. Average water levels in Honey Lake are about 2 feet (0.6 metre) lower than in spring 1975.

In the Sacramento Valley, including the Redding Basin, average ground water levels are down about 6 feet (1.8 metres) with the west side suffering a greater drop than those on the east side. Butte and Sutter County water levels are down about 5 feet (1.5 metres) from last spring. Water levels on the average are 6 feet (1.6 metres) lower in Yuba County, 4 feet (1.2 metres) lower in San Joaquin and Solano Counties, and 3 feet (0.9 metre) lower in Sacramento and Placer Counties. In Yolo County, where the average spring level was 7 feet (2.1 metres) lower than in the previous spring, some wells in April were already reflecting levels normally expected in midsummer.

In the San Francisco Bay area, water levels have also declined. In Santa Clara County, the average drop was 15 feet (4.6 metres) and wells in the southern part of the county were down more than 30 feet (9.1 metres). The level in the Russian River area indicated a decline of about 4 feet (1.2 metres) and Livermore Valley wells were down 2 feet (0.6 metre).

In the San Joaquin Valley, ground water levels have declined gradually for several years from the Chowchilla River area southward to the Tehachapi mountains, except in a very few areas. This trend levels out during years of heavy runoff and might even show a rise for a few years; however, the trend has been downward over a long period.

Along the west side of Fresno County, since State Project water has been available, the ground water levels have shown a considerable rise in the confined aquifer due to decreased pumping. Water levels from the spring of 1975 to the spring of 1976 from the Chowchilla River south (except in the Mendota-Huron area) show a drop ranging from 2.0 feet (0.6 metre) to 23 feet (7.0 metres) in 15 of 20 basins or areas that were measured. Shafter-Wasco Irrigation District showed the greatest decline, 23 feet (7.0 metres); the Madera, Kaweah Delta, Tulare, and Lower Tule areas show declines of 7 to 8 feet (2.1 to 2.4 metres); and Pleasant Valley, 10 feet (3.0 metres). Other areas showed a slightly smaller decline. Four areas showed a very slight rise from 1 to 3 feet (0.3 to 0.9 metres). It is reported that in a few wells in the Chowchilla area the water level has dropped as much as 25 feet (7.3 metres), and some pumps have lost suction.

In the Salinas Valley, ground water levels have declined about 6 feet (1.8 metres) from March 1975 to March 1976.

In Southern California, heavy pumping in San Luis Obispo County has caused some drop in the ground water table in the Paso Robles area along the Salinas River and east of the river toward Shandon.

1976 DRY YEAR IMPACTS AND STRATEGIES

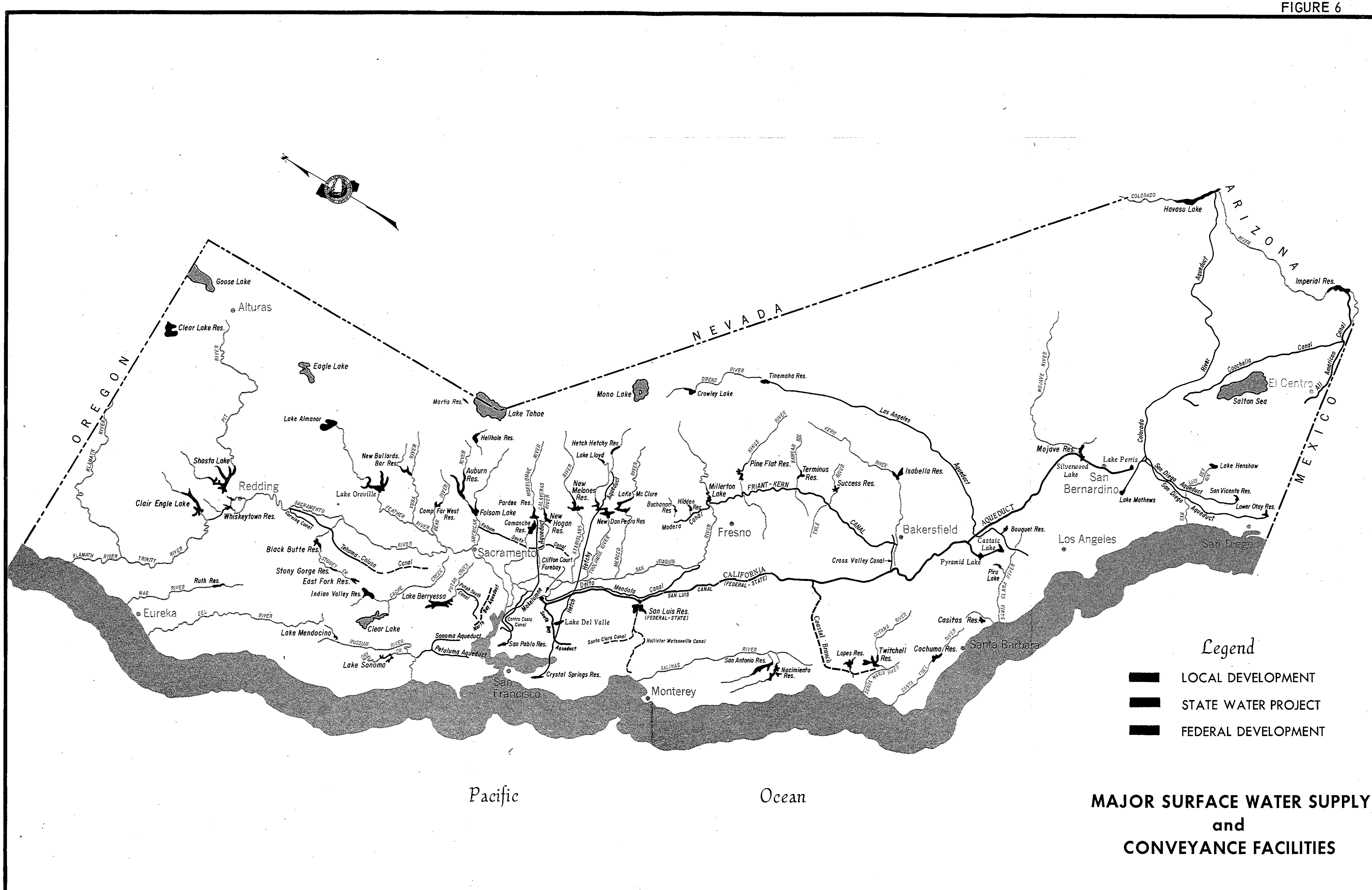
California is particularly rich in natural water resources. Its mountain streams are rarely dry in "normal" years, when the many mountain watersheds produce large amounts of surface water in response to rain and snow in the fall, winter, and spring, and maintain a base flow in the usually dry summers. The many ground water basins are dominated by the great Central Valley basin which has a usable storage capacity of over 100,000,000 acre-feet (1 233 million cubic kilometres).

Early settlement took place along stream courses and the development of the deep-well turbine pumps later made pumping practical throughout the valley on land overlying ground water basins. Subsequent growth of the metropolitan areas around Los Angeles and the San Francisco Bay area stimulated the development of reservoirs and aqueducts to bring water from east to west from the Colorado River and from the Sierra Nevada as shown on Figure 6, "Major Surface Water Supply and Conveyance Facilities". In the 1930s, the State Water Plan was developed in recognition of the need for storage reservoirs in the Central Valley to supplement local streamflow and the ground water basins, above which a great agricultural development was growing. Most of these reservoirs were built by federal and local agencies during the 1940s, '50s, and '60s. Some, like Auburn Dam on the North Fork of the American River, are even now under construction. In 1960, the State authorized the bonds to construct the State Water Project, which extends from Oroville Dam on the Feather River through a system of aqueducts and reservoirs reaching from the Sacramento-San Joaquin Delta over the Tehachapi Mountains to Los Angeles. A vast network of local dams and conveyance facilities have also been constructed throughout the State over the years by local agencies to develop smaller streams and to deliver local water as well as water from the larger systems. In a normal year, about half of the more than 30,000,000 acre-feet (37.005 cubic kilometres) of water put to use each year in California is taken from ground water and half from surface water.

Statewide Summary

All large reservoir and conveyance systems will meet their demand for water covered by firm contracts, except in the Friant-Kern and Madera Canals Service Areas, where only 70 percent of Class I water (firm contract) is expected to be delivered. In the Central Valley and other large ground water basins, agricultural and urban users may have to pump from deeper levels, but a full water supply is available where wells are functioning. Failure of a substantial number of wells is anticipated.

FIGURE 6



MAJOR SURFACE WATER SUPPLY and CONVEYANCE FACILITIES

Problems are widespread among small communities served from small surface reservoirs, particularly along the coast north and south of San Francisco and in the foothill areas of the Central Valley. In shallow mountain and coastal ground water basins, problems are also developing.

Dry-farmed grain and rangeland have been hard hit by the lack of rain. Thirty counties have applied for Natural Disaster Status; 24 have been approved by the U. S. Department of Agriculture, three have been self-approved, two have been rejected, and one is still pending.

Fish and wildlife will suffer reproductive losses throughout the State. The anadromous fishery, including striped bass, will probably be the most severely impacted, and will feel the residual effects of the drought for several years.

Recreation will be available throughout the year at many lakes and reservoirs. However, many reservoirs will be drawn down during the summer and their water levels will fall below the bottoms of boat ramps and improved beaches. Large craft may not be able to be launched on some lakes, but smaller craft will not be unduly affected, except by unattractive shoreline conditions at some locations. Boaters should be careful of increased boating hazards. River flows will be lower than normal in many streams used for kayaking, canoeing, and rafting; a change of craft or a switch to different streams may be necessary.

The State will face severe fire problems this summer and fall. Fires are expected to be more frequent, hotter and more difficult to control.

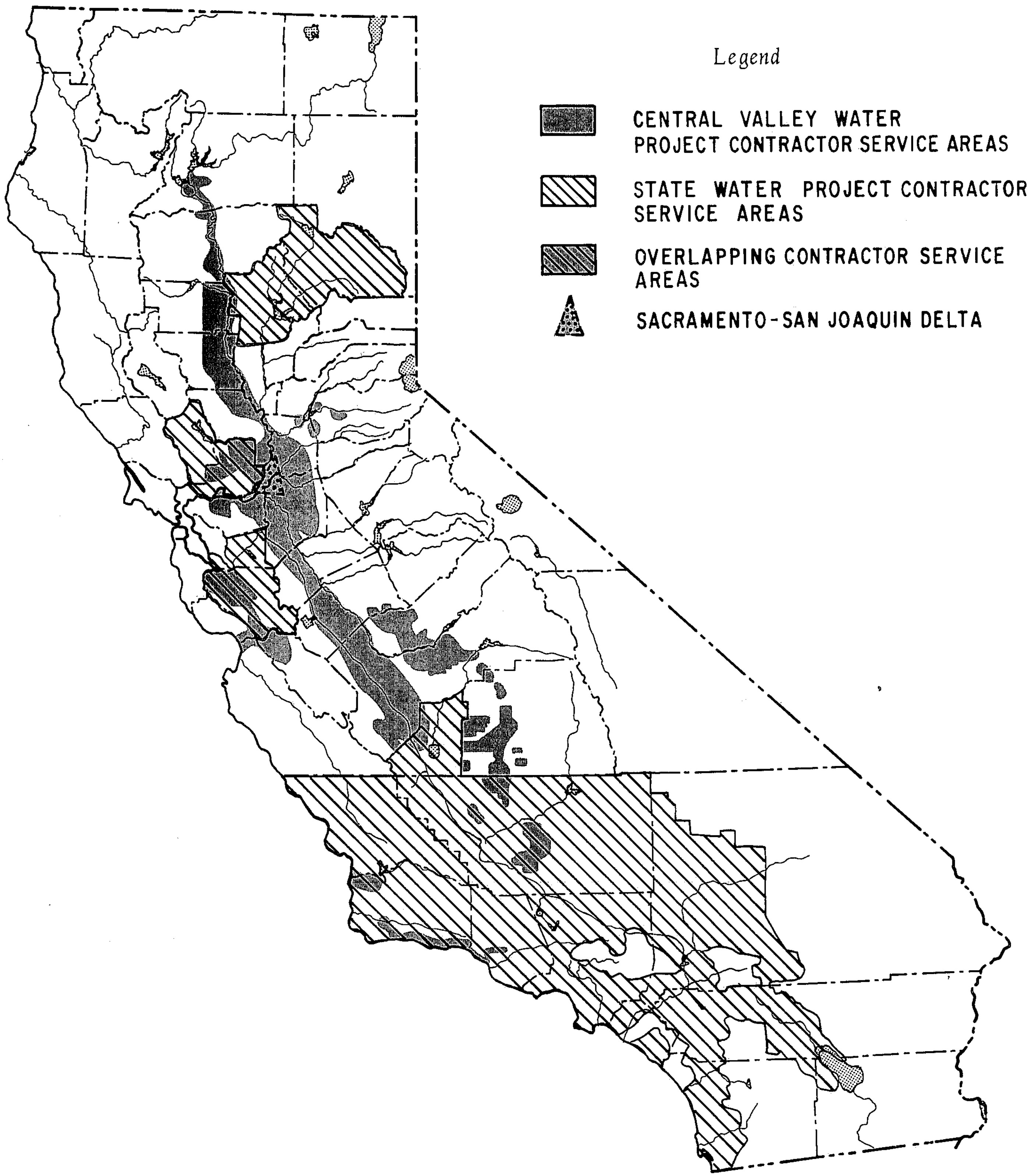
Energy used in California is derived predominantly from fossil fuels. Hydroelectric power is used widely for peaking loads. Hydropower this year will be reduced by the equivalent of about 28 million barrels of oil, due to the dry year. However, availability of excess power from the Pacific Northwest, along with power from sources other than hydroelectricity, are expected to be sufficient.

State Water Project - Central Valley Project - The Delta

Because of the configurations of their facilities, the State Water Project and the Central Valley Project are mutually interdependent. Figure 6 shows that releases from upstream reservoirs of the Central Valley Project, such as Shasta, and releases from Oroville Reservoir of the State Water Project meet in the Sacramento-San Joaquin Delta, where water is diverted to both the Delta-Mendota Canal of the Central Valley Project and the California Aqueduct of the State Water Project. As a result, the operational activities and objectives of the Bureau of Reclamation and the State are closely coordinated, particularly during a dry year such as 1976. Service areas for these projects are shown on Figure 7.

FIGURE 7

STATE WATER PROJECT AND CENTRAL VALLEY PROJECT CONTRACTOR SERVICE AREAS



A major objective of the U. S. Bureau of Reclamation and the Department of Water Resources during this year is maintenance of state and federal water quality objectives in the Delta, while responding to requests for project water to the greatest extent possible. The cumulative effect of the development of the conservation reservoirs of the Central Valley and State Water Projects, as well as the coordinated operations of the two agencies on dry year water quality in the Delta, is illustrated by Figure 8. This figure shows the extent of salinity incursion in 1924 and 1931, the dry years of record, and the incursion projected for 1976. In 1931, the salinity incursion reached Stockton. In 1976, the incursion is projected to remain west of Blind Point, a water quality measuring station on the San Joaquin River located about 5 miles (8.0 kilometres) east of Antioch.

State Water Project

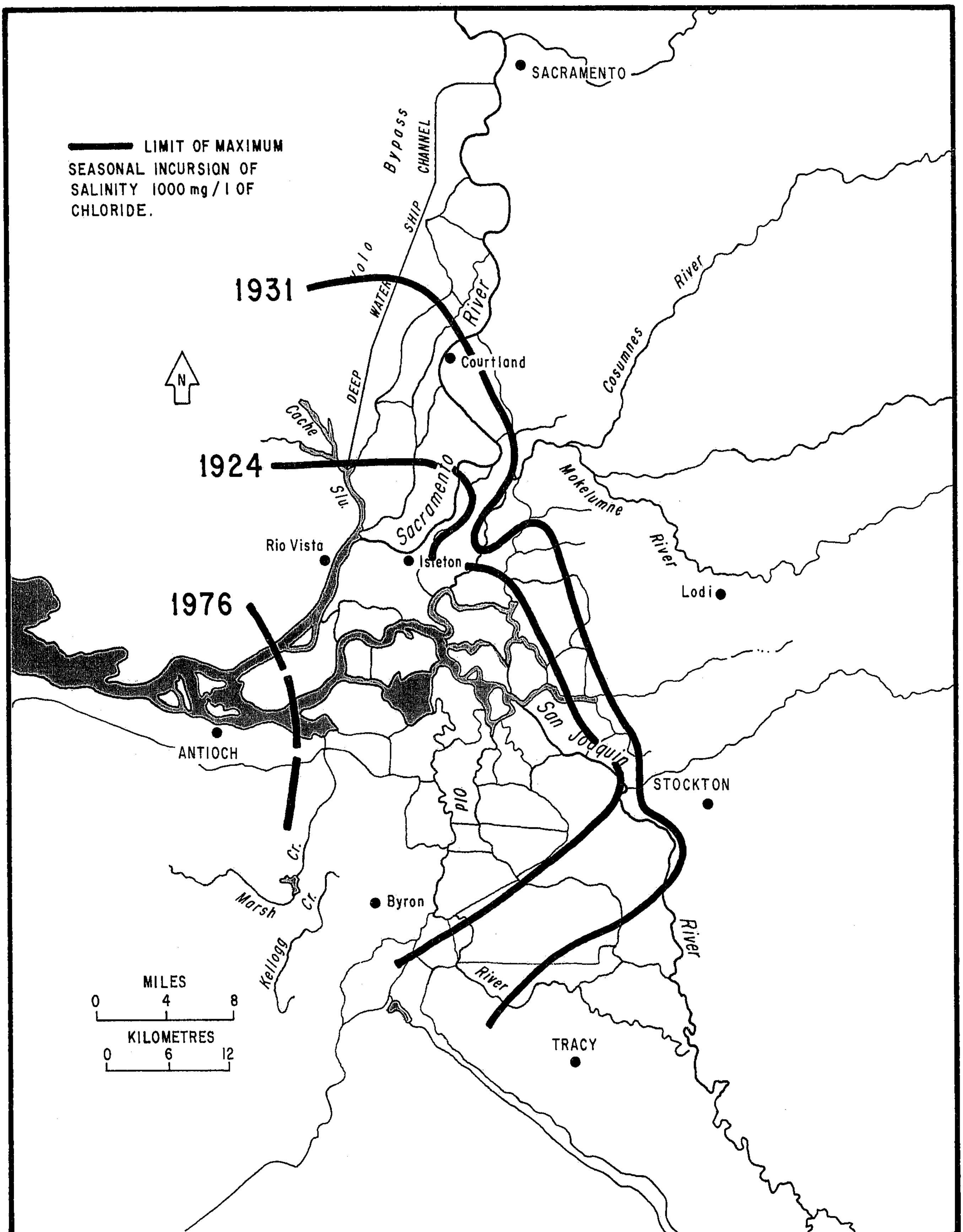
The State Water Project is being operated under the concept of meeting all entitlement deliveries, about 1,380,000 acre-feet (1.702 cubic kilometres), and delivering at least 580,000 acre-feet (0.715 cubic kilometres) of surplus. The operation is planned so that sufficient water will be available to meet entitlement deliveries, in the event the water supply in 1977 is about equal to 1931.

Inflow to Oroville Reservoir is estimated to total about 1.9 million acre-feet (2.34 cubic kilometres). While this volume is greater than would have occurred in the historic dry years of 1924 and 1931, it is about 850,000 acre-feet (1.048 cubic kilometres) below the lower quartile volume. Releases are being made to meet Delta water quality criteria, to supply water to meet diversion needs from the Delta, and to meet all other commitments, including power. As a result of this operation, it is anticipated that the storage in Oroville will be reduced to about 1.6 million acre-feet (1.974 cubic kilometres), or an elevation of about 740 feet (226 metres). This is expected to be the minimum storage since the reservoir was initially filled in 1969.

To comply with water quality criteria in the Delta, State Water Project diversions from the Delta have, for the most part, been limited to those necessary to meet deliveries to the South Bay Aqueduct since April 1 and this limitation is expected to prevail at least through June. Beginning in July diversions from the Delta will increase but are expected to be only about 75 percent of normal for July through September. As a result, a large share of project deliveries to the San Joaquin Valley and Southern California are being made from project reservoirs, particularly the State's share of San Luis Reservoir. Total storage in this reservoir is expected to decrease from a maximum of about 1,965,000 acre-feet (2.424 cubic kilometres) in late March to a minimum of about 700,000 acre-feet (0.863 cubic kilometres) by

FIGURE 8

ESTIMATED SALINITY INCURSION 1976 AS COMPARED TO OTHER DRY YEARS



September 1. The State's share of this minimum is expected to be about 300,000 acre-feet (0.370 cubic kilometres). Both of these minimum values will be the lowest recorded since the reservoir was initially filled. Project reservoirs in Southern California are not expected to be affected by problems related to the dry year, except that further reservoir filling will be curtailed until at least September.

The surplus[a] water deliveries planned for 1976 represent only about 64 percent of the amount requested by the contractors, because of the dry year conditions. The delivery of any additional surplus water will depend on conditions prevailing in the fall. This action is requiring some of the agricultural users in the San Joaquin Valley to consider adjusting their operations and reducing their water use. In some instances, it is understood that ground water will be utilized to supplement surface supplies, even though the quality of such water may be poor. Particular attention is being paid to ensure that sufficient water is available to protect perennial crops, such as fruit and nut trees, even if it results in the loss of some annual crops this year.

Central Valley Project

The U. S. Bureau of Reclamation, the operator of the Central Valley Project, plans to deliver a total of 5.85 million acre-feet (7.216 cubic kilometres) of water from project facilities during 1976. This will provide a normal supply to all customers, except those receiving water from Millerton Lake on the San Joaquin River, where runoff was only sufficient to provide about 70 percent of a Class I[a] supply. No Class II water will be available. It is expected that all power commitments will be met.

Inflow to Lake Shasta is estimated to total about 3.5 million acre-feet (4.317 cubic kilometres) which is classified as a dry year and slightly below lower quartile. The U. S. Bureau of Reclamation considers a lower quartile to be about 60 percent of normal. Inflow to Folsom Lake is estimated to be 700,000 acre-feet (0.863 cubic kilometres), which is about 30 percent of normal, while inflow to Millerton Lake is estimated to be 580,000 acre-feet (0.715 cubic kilometres), again about 30 percent of normal.

By October 1 it is anticipated that storage in Lake Shasta will be reduced to 1.0 million acre-feet (1.234 cubic kilometres), and in Folsom Lake to 350,000 acre-feet (0.432 cubic kilometres). Both of these values are record lows since initial reservoir filling. Clair Engle Lake on the Trinity River is expected to have a storage of 1.7 million acre-feet, (2.097 cubic kilometres), the second lowest of record, while the U. S. Bureau

[a] Defined in Appendix A.

of Reclamation's share of storage in San Luis Reservoir is expected to be reduced to 400,000 acre-feet, (0.493 cubic kilometres), a record low. Whiskeytown Reservoir will remain essentially full; however, storage at other U. S. Bureau of Reclamation reservoirs will be diminished. For example, Lake Berryessa of the Solano Project is expected to be drawn down to about 1.0 million acre-feet (1.234 cubic kilometres), or about 60 percent of capacity, while Black Butte Reservoir of the Central Valley Project is expected to be reduced to dead storage.

Project deliveries are expected to total 5.85 million acre-feet (7.216 cubic kilometres), of which about 2.0 million acre-feet (2.467 cubic kilometres) will be delivered to the Sacramento River Service Area shown in Figure 7. In addition, about 3.0 million acre-feet (3.701 cubic kilometres) will be delivered to areas in the San Joaquin Valley served by diversions from the Delta through the Delta-Mendota Canal or by releases from San Luis Reservoir. These deliveries consist of Delta-Mendota Canal, 600,000 acre-feet (0.740 cubic kilometres), Mendota Pool, 975,000 acre-feet (1.203 cubic kilometres), and San Luis Canal, including Westlands Water District, 1,400,000 acre-feet (1.727 cubic kilometres). The Bureau of Reclamation is providing about 950,000 acre-feet (1.172 cubic kilometres) of interim water, which is yield dedicated to future projects such as the Mid-Valley Canal and the San Felipe Project. Of this total, 750,000 acre-feet (0.925 cubic kilometres) is being devoted to the maintenance of quality standards in the Delta above the level the U. S. Bureau of Reclamation feels it is legally required to maintain, and 200,000 acre-feet (0.247 cubic kilometres) is included in the amount scheduled for delivery from the San Luis Canal.

Agricultural Areas

Agriculture in California includes 9,000,000 acres (3 642 210 hectares) of irrigated land, nearly 2,000,000 acres (809 380 hectares) of dry-farmed grain, and about 20,000,000 acres (8 093 800 hectares) of dry-farmed rangeland. Irrigated lands receive water from the State Water Project and the Central Valley Project (See Figure 7) from more localized storage and conveyance systems, the major and minor ground water basins of the State, and from direct diversion of streamflow. The Imperial and Coachella Valleys and Palo Verde Irrigation District receive irrigation water from the Colorado River system in the southeastern part of the State.

Dry-Farmed Areas

Approximately 22,000,000 acres (8 903 180 hectares) of dry-farmed grain and pastureland are located in the foothills and along the valley edges in the Central Valley, in mountain valleys throughout the State, and in the desert areas of Southern California. These are presented in Figure 9, "Dry-Farm and Grazing Lands of California".

During the winter of 1975-76, and on through the spring of 1976, the lack of precipitation in the dry-farmed areas caused these areas to suffer a loss of $315,000,000, with two-thirds of the loss occurring in livestock and dairy production according to the State Department of Food and Agriculture. The Department reports that cattle and dairy production suffered a $265,800,000 loss, the sheep industry lost $3,500,000, fruit and nut crop losses are estimated at $22,700,000, and grain losses totaled $22,800,000.

These losses triggered local government action to have 30 counties declared Natural Disaster Areas; thus making a number of loan and subsidy programs of the Federal Government available to affected farmers. Three of the counties, San Bernardino, San Diego, and Tuolumne, had fewer than 25 farmers affected and were able to authorize U. S. Department of Agriculture programs without obtaining its approval. The other 27 county requests to the Governor were subsequently the subject of a request to the U. S. Department of Agriculture for the Natural Disaster Area status. San Mateo County's request is still pending, and the requests for Alpine and Butte Counties were denied. The remaining counties listed below were approved by USDA and disaster programs are now available to those farmers affected:

ALAMEDA	LOS ANGELES	SAN JOAQUIN
AMADOR	MADERA	SAN LUIS OBISPO
CALAVERAS	MERCED	SOLANO
COLUSA	MONTEREY	STANISLAUS
CONTRA COSTA	NAPA	SUTTER
FRESNO	NEVADA	TEHAMA
GLENN	RIVERSIDE	TULARE
KINGS	SAN BENITO	YOLO

The counties affected are shown on Figure 10, "Drought Disaster Counties of California, 1976".

Some of the programs now available to the 27 approved counties are:

Crop Loss - PL 93-86 provides financial assistance to wheat, grain, and cotton farmers suffering losses when they are prevented from planting by conditions beyond their control.

Emergency Livestock Feeding - Assistance at beneficial prices to livestock owners in the emergency area.

Farmers Loans - Emergency loans can be made to farmers in the affected area.

FIGURE 9

DRY-FARM AND GRAZING LANDS OF CALIFORNIA

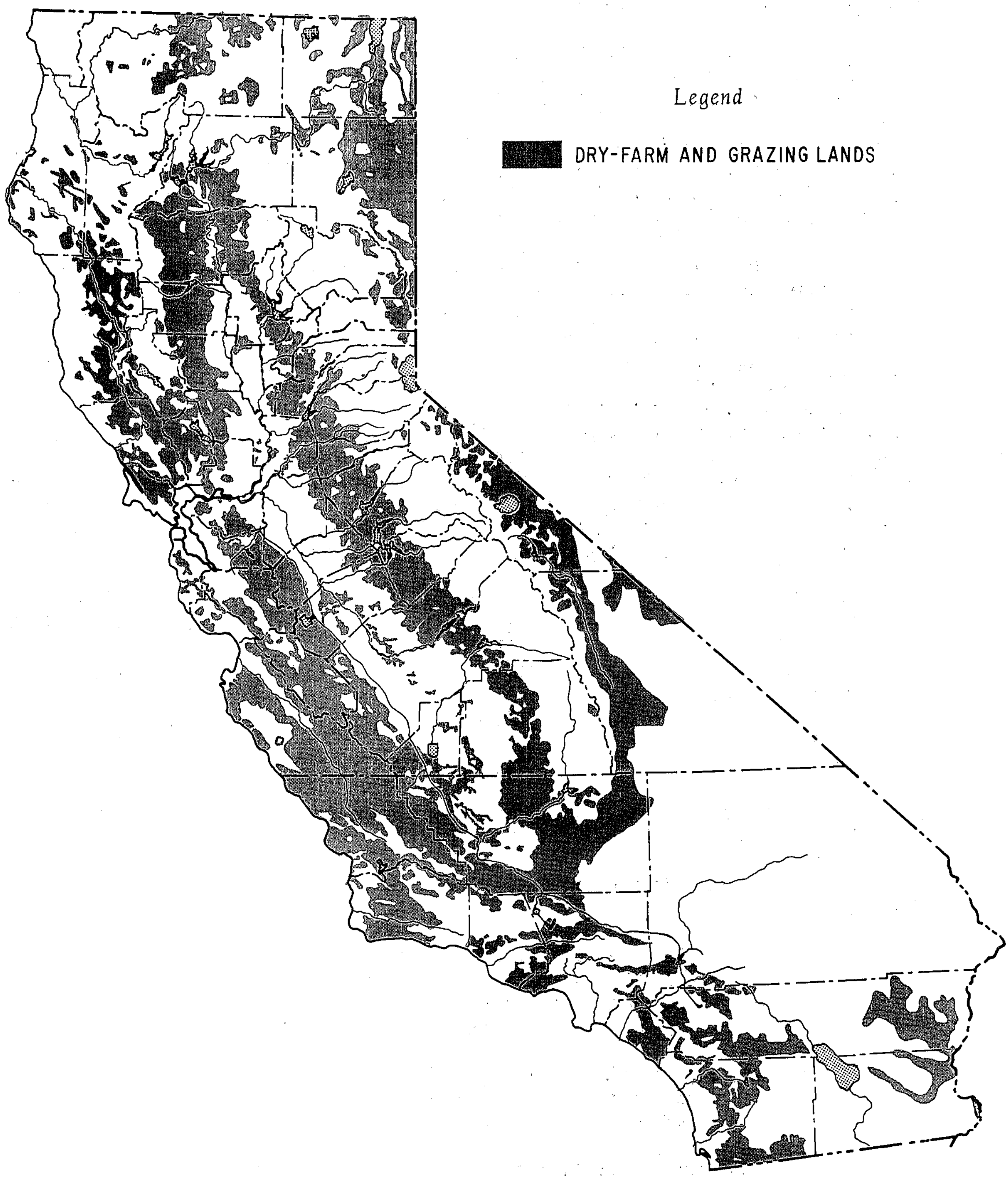
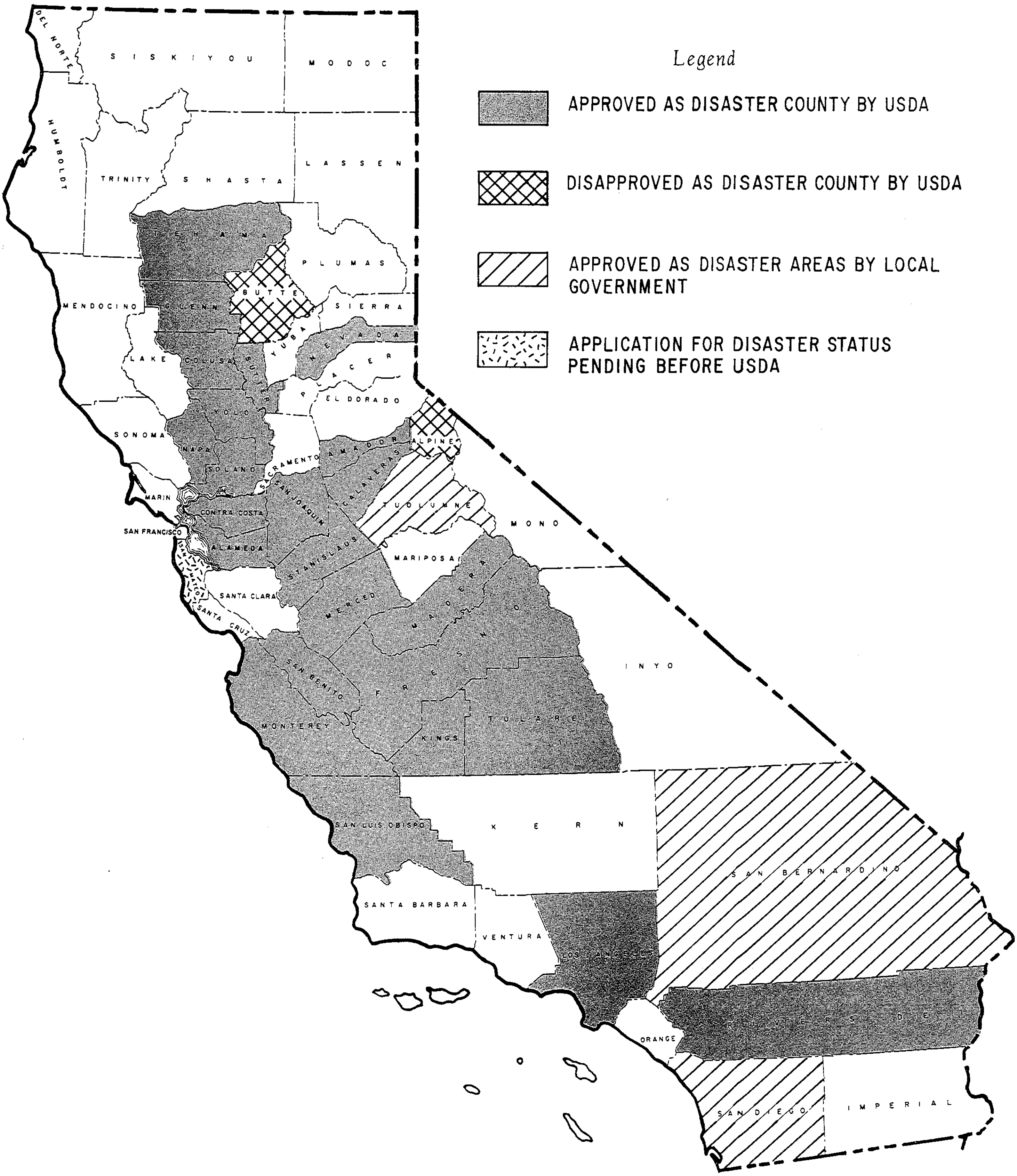


FIGURE 10

DROUGHT DISASTER COUNTIES OF CALIFORNIA

MAY 4, 1976



Rail Freight Rate Reduction - Lowering of rail rates for hauling of feed.

The grain planted last fall in the Central Valley was germinated by the October rains. Lack of subsequent rain, however, inhibited growth and most of the grain was either replanted in anticipation of spring rains or used as pasture. If harvested, most crops will be poor.

In the Central Coastal Area, an additional inch of rain by early June could yet save the crop; otherwise, a 50 percent loss is expected. Farmers may not even get their seed investment back.

Small grain acreages in the South Coastal Area, where precipitation was near normal this year, will have near-normal yields. Northern California mountain valleys are expecting a below-normal grain yield ranging from 50 to 75 percent of normal.

The dry-farmed rangeland problem in all parts of the State involved lack of stock water, as well as lack of forage. Many ranchers moved livestock to market, including breeding stock in some cases, rather than truck water and buy hay. Those who tried to maintain animal populations encountered a sellers' market in hay and feed which has driven the price of hay to over $100 per ton ($110 per tonne) in some areas. A single bale in some areas is going for as much as $9. The long-term result may be continued high hay and feed prices and fewer cattle on the range and in the feedlots next year.

Irrigated Areas

Far-below-normal runoff into reservoirs of the Central Valley, the northeastern counties area, and the coastal area from Jenner on the north to Santa Barbara on the south will cause surface water deliveries for agriculture to fall to below-normal amounts, except in contractor service areas of the Central Valley Project (excluding that served from Friant Dam), the State Water Project Contractor Service Area (Figure 7) and the Modesto and Turlock Irrigation Districts. Shallow ground water basins in these same areas received less than adequate recharge last winter, and local problems may occur. Less than a full supply for irrigation in the northeastern counties area can be expected for those water users directly diverting stream flow.

No problems are expected this year in agricultural areas served by the Colorado River, principally the Palo Verde Irrigation District, and the Imperial and Coachella Valleys. Farmers customarily relying on the major ground water basins of the State may experience an abnormal lowering of water levels, but water is available. The North Coastal Area from the Eel River drainage north to the Oregon Border received near-normal precipitation and no unusual problems should occur.

The usual strategy described in discussions with Central Valley surface water project operators who are experiencing a below-normal supply is to serve all the water possible on demand of the users, carrying little or no water over to guard against a dry 1977 except in the Central Valley Project, the State Water Project System, New Don Pedro Reservoir, and Lake McClure. This strategy is based on the belief that a good crop this year is desirable, since next year will probably be a near-normal or better water supply. In some areas, water was needed and served early in the season to make up for the subnormal precipitation on nuts, fruit, and vineyards. In some instances, where the surface water shortage will be offset by pumping more ground water, surface water is being held for delivery during the peak months of water demand, July and August.

Impacts of the drought in the Sacramento Valley are varied. Although the Oroville-Wyandotte Irrigation District has shut down all its power generating facilities, it reports it has enough water to supply its irrigation needs for the current water year. Farther south along the Sierra Nevada foothills, the Nevada Irrigation District has some carry-over storage from last year and expects normal deliveries of irrigation water throughout the season; but it has asked its customers to conserve water wherever possible.

On the west side of the valley, the Orland Water Users Association, which covers 19,723 acres (7 892 hectares), reports it expects to receive 55,000 acre-feet (1.068 cubic kilometres) of water from East Park and Stony Gorge Reservoirs on Stony Creek. Its normal demand is 121,000 acre-feet (0.149 cubic kilometres). The result is a deficiency of about 66,000 acre-feet (0.081 cubic kilometres). The U. S. Bureau of Reclamation is releasing all water from East Park and Stony Gorge down into Black Butte Reservoir, thus saving about 5,000 acre-feet (0.006 cubic kilometres) of evaporation and other losses during the season.

In the Orland area, many users are drilling more wells because the available surface water is being apportioned on an acreage basis, regardless of the crop grown. Pumps have been purchased by the Association for surface water diversions so that some water can be obtained from the Tehama-Colusa Canal for 3,600 acres (1 457 hectares) in the eastern portion of the area. There will be no double-cropping this year, and some dairymen are obtaining portable aluminum sprinkler systems. Farmers are signing up for what little additional water may be available from Black Butte Reservoir.

In the Sacramento Valley southwest of Chico, the M & T Ranch reports it will have only a 55 percent of normal supply from Butte Creek. It plans to pump from the Sacramento River and cut back about 25 percent of its normally irrigated acreage.

The Placer County Water Agency reports a full supply will be available from the Pacific Gas and Electric Company's Yuba-Bear System, but usage is running above normal and customers are asked to prevent waste. System canals are being closely checked for leakage.

A serious situation is being faced in Yolo County. The Yolo County Flood Control and Water District reports that Indian Valley Reservoir, just completed last year, had a storage of 106,000 acre-feet (0.131 cubic kilometres) on March 10, but is now down to about 81,000 acre-feet (0.100 cubic kilometres). Since no water will be available from Clear Lake, it is anticipated that the District will be out of water by the end of July or early August. When Indian Valley reaches dead storage, 4,000 acre-feet (0.005 cubic kilometre), irrigation water will be cut off. Meetings have been held with local farmers on the impending cutoff. Most of the irrigation water goes to orchards and many of the orchards and fields will become dormant. Walnut orchards will be hardest hit since many of these have no supplemental ground water supplies. The District estimates that it can supply approximately 1.2 acre-feet per acre (0.366 metre depth) for irrigation, which is inadequate. Some of the water users are putting in wells; however, the yield is very low (approximately 200 gallons per minute) (12.6 litres per second), in many areas. Farmers who have wells will pump more than twice as much water as usual. Farmers have responded to the dry season by shifting from sugar beets and rice to corn and other crops which do not require as much water. This will result in a net reduction of yield estimated at $6 to $8 million in 1976, and, since they cannot double-crop, the estimated total reduction will amount to over $40 million, according to the Yolo County Flood Control and Water District.

In the San Joaquin Valley the big story is the deficiency in Class I water available from Friant Dam. This year is the third in which a deficiency in delivery of firm entitlement (Class I) has been necessary; the first was in 1961 when runoff on the San Joaquin River was 39 percent of normal; the second was in 1968. The Friant-Kern Canal supplies water to 685,000 irrigated acres (277 000 hectares) which make up 79 percent of the gross area of the various irrigation and water districts in the service area with average project allocation of 1,144,000 (1.4 cubic kilometres). Since there is no Class II water available this year, the difference between project allocation and the available Class I water (about 70 percent of 660,000 or 462,000 acre-feet) (0.8 or 0.57 cubic kilometres) is 682,000 acre-feet (0.84 cubic kilometre), which must be obtained from ground water.

The Madera Canal also begins at Friant Dam and serves some 142,000 acres (57 400 hectares), with average project allocation of 313,000 acre-feet (0.39 cubic kilometre). Class I water for this area is 140,000 acre-feet (0.17 cubic kilometre), but only 70 percent, or about 98,000 acre-feet (0.12 cubic kilometre), will be delivered this year. Thus the additional water to meet requirements of about 215,000 acre-feet (0.26 cubic kilometre) must be obtained from ground water.

Surface water supplies available from the Kings, Tule, Kaweah, and Kern River systems will be about 35 percent of normal. Additional ground water pumping will be necessary throughout the eastside of the San Joaquin Valley.

Under normal conditions, ground water overdraft in the San Joaquin Valley is estimated at about 1,500,000 acre-feet (1.85 cubic kilometres) per year. With the additional pumping this year, ground water withdrawals are expected to exceed normal pumping by about 2,000,000 acre-feet (2.5 cubic kilometres) over normal pumpage. Areas that are not served by surface water systems depend totally on ground water and will probably be affected by the lowered water tables and increased pumping costs. The water table may fall beyond the reach of some shallow wells, requiring pump bowls to be lowered or wells to be deepened.

The Merced Irrigation District will levy an additional water charge of $3.60 per irrigated acre ($8.90 per irrigated hectare) to promote water conservation and to provide revenue for pumping about 200,000 acre-feet (0.25 cubic kilometre) of ground water that will supplement the short surface supply. No problem is expected because ground water levels are high. The Modesto and Turlock Irrigation Districts are projected to operate close to their normal method and will have 867,000 acre-feet (1.1 cubic kilometres) of carryover storage in New Don Pedro Reservoir on October 1, 1976. This is the greatest amount of carryover storage of all the eastside of San Joaquin Valley reservoirs.

The Stanislaus River System, which serves the Oakdale and South San Joaquin Irrigation Districts, will supply about half the normal demand of 600,000 acre-feet (0.74 cubic kilometre). The plan of operation is to hold releases at about 1,000 cubic feet per second (28.3 cubic metres per second) until the system runs dry about the end of August, after which time ground water will be the only source of supply. South San Joaquin Irrigation District has district-operated drainage pumps which can supply about 5 percent of its total demand. To get maximum benefit from its water supply, the district is using methods normally used in water-short years: rationing and extending the time between irrigations. In Oakdale Irrigation District, ground water pumps are individually owned, except for 25 district-operated pumps which can produce a total of 80 cubic feet per second (2.3 cubic metres per second). Many of the private pumps have been disconnected for several years to save the standby charge. As a result, farmers are faced with a 6- to 8-week wait until Pacific Gas and Electric Company reconnects their pumps.

Pine Flat Dam stores water for several irrigation districts. Release of water from the reservoir will be on demand, and the water level will be drawn down to 731 feet (223 metres), the lowest elevation since it was constructed. Fresno Irrigation District, one of the Kings River water users, commenced water deliveries May 1 (normal starting date is March 1) and expects to have enough water to last through June. Farmers will then use their privately-owned ground water pumps.

Some of the entities with water entitlement from the Kings River may have only enough water stored for half an irrigation round. These may decide to pump ground water and wait until there is sufficient stored water for a complete irrigation round.

Reports from drillers and pump companies ranged from keeping up with the increased work to one with a 10-times normal backlog. Some drillers are already booked for the next 3 months. The most commonly reported problem in putting wells into service is lowered water tables. An increase in new irrigated land development due to improved economic conditions is adding to the work load. One driller commented that the increase so far is manageable, but that the real rush will come when heavy pumping starts. If wells fail at that point, there would not be time to replace them during the irrigation season.

The Salinas Valley along the Central California coast has no problem because the area is served by ground water. Nacimiento and San Antonio reservoirs will carry over water for possible use in 1977. These reservoirs are used to recharge ground water. The only canal delivery systems are those used on farms. Releases to ground water recharge began in January this year. However, to the north near Santa Cruz, the small agricultural water use will probably be cut back about 30 percent. The main effect will be on brussel sprouts.

In the northeastern counties, streamflow is much below normal. Many farmers depend on direct diversion of streamflow for irrigation of pasture. In some areas of Lassen County only one good irrigation will be achieved this season. Crop yield will be reduced about 50 percent. Many of the smaller reservoirs in the Devils Garden area of Modoc County are either dry or at extremely low levels.

The Lassen Irrigation Company serves 5,800 acres (2 366 hectares) from McCoy Flat, Hog Flat and Leavitt Reservoirs. The normal supply is about 18,000 acre-feet (0.02 cubic kilometres), but this year only 8,900 acre-feet (0.01 cubic kilometre) is available. As a strategy to save evaporation, water will be transferred from McCoy Reservoir to Leavitt Reservoir. Users from the system will receive only one irrigation, with alfalfa yields expected to be 50 percent of normal for the year. Some shortage of stock water in ponds is also expected.

Urban Areas

In many areas of California, community, municipal, and industrial water supplies will present no problems. The metropolitan areas of Southern California are served by a large water system from the Colorado River which has an excellent water supply situation, and the State Water Project has announced that all firm contracts will be met. The City of Los Angeles also receives water conveyed by the Los Angeles Aqueduct, which originates near Bishop in the Mono Lake-Owens Valley area, and, except for a possibility of less water available for use on lands owned by the City of Los Angeles in Owens Valley, no shortage is expected.

San Joaquin Valley communities are served by ground water, which is plentiful, but which may be drawn down more this year than usual due to extremely heavy pumping by irrigators. No specific reports of expected problems have been received.

Sacramento Valley communities receive water from adjacent reservoirs or from the Sacramento River or its major tributaries. Some problems may occur because of low river stages.

The metropolitan areas near San Francisco Bay, which are served by the City of San Francisco's Hetch Hetchy System and several local reservoirs, expect no water supply problems this summer. The same holds true for areas served by the East Bay Municipal Utility District which brings water from Pardee Reservoir on the Mokelumne River in the Sierra Nevada.

Communities in the northeastern counties area receive their supply mostly from ground water, and no problems are anticipated. Water rates in the City of Susanville have recently been increased. This could, in itself, encourage use of water conservation practices.

The desert areas of Southern California use ground water as a supply for most communities, and no potential problems are reported.

The North Coastal Area of California, from the Eel River northward through the Smith River drainage near the Oregon border, received near-normal precipitation this year and is not expected to have water supply problems.

Municipal water supply problems caused by the dry year are tabulated on Table 4, "Municipal and Industrial Water Supply Problem Areas, 1976 Water Year", and are discussed below.

Urban problem areas in Southern California are occurring along the coast north of Los Angeles. They are minor, except in the City of Morro Bay, where the ground water supply is marginal and chlorination facilities are being built, in the event water from Whale Rock Reservoir is required. A voluntary conservation program is being practiced, and the City has passed ordinances requiring water-saving plumbing devices in new construction.

Urban problems in the Sacramento River drainage are occurring predominantly in the foothill communities, except in the community of Yolo, where some wells have become dry. The City of Chico, served by the California Water Service Company, receives an adequate ground water supply; however, the company has started an anti-waste campaign.

TABLE 4

Municipal and Industrial Water Supply Problem Areas
1976 Water Year

Project/Area or City	Supply/Demand	Water Management Operational Strategy	Impacts on Users: Problems/Actions to date (5/1/76)	Impacts on Users: Expected Problems/Action
Southern California				
L. A. Department of Water & Power	Adequate	Increased purchase of water from Metropolitan Water District of Southern California Increased ground water pumping in San Fernando Valley Less water available for use on city-owned lands in Owens Valley		Reduction in hydroelectric generation and additional energy required to pump SWP water would result in greater fuel oil consumption for energy generation in Los Angeles Basin.
City of Morro Bay	Questionable Supply	Chlorination facilities are presently under construction in case water from Whale Rock Reservoir is required to meet the demands	Voluntary conservation program being practiced. City has passed ordinance requiring new construction to install water-saving plumbing devices.	Plans are being formulated for purchasing water-saving fixtures.
Santa Barbara County	Adequate	No real impact because of large carryover storage in surface reservoirs and ample supplies in the ground water basins.	(Conservation programs implemented prior to the dry period continue to be practiced in the South Coastal areas.)	Lompoc area expects an adverse trend in its normally poor water quality (TDS), if the dry period continues.

TABLE 4 (Continued)

Municipal and Industrial Water Supply Problem Areas
1976 Water Year

Project/Area or City	Supply/Demand	Water Management Operational Strategy	Impacts on Users: Problems/Actions to date (5/1/76)	Impacts on Users: Expected Problems/Action
Sacramento River Drainage				
Lakeport	Scotts Creek Ground water basin	Hope supply is adequate	None	Questionable, see text
Paradise I.D. and Magalia Co. W.D.	68% 25%	Declare emergency, raise rates, threaten rationing, adopt water conservation methods, contract to purchase emergency water from PG&E.	Water costs more	Cut back planting of home gardens.
Chico	100%	Calif.Water Service Co., the supplier, has issued brochures and flyers re waste of water.	None	None
Nevada Irrigation District Service Area	Slightly below normal	Newspaper publicity on domestic water conservation.	None	None
Quincy	Reservoirs low	Rationing to cut demand, seeking deep well sites.	Rationing	None
Butte County Foothills Swede's Flat, Bald Rock, Bangor, Berry Creek, Feather Falls, and Cherokee	Local ground water and stream flow.	None	None	Problems expected.

TABLE 4 (Continued)

Municipal and Industrial Water Supply Problem Areas
1976 Water Year

Project/Area or City	Supply/Demand	Water Management Operational Strategy	Impacts on Users: Problems/Actions to date (5/1/76)	Impacts on Users: Expected Problems/Actions
Shasta County: Churn Creek Bottom	Ground water	Clear Creek Community Services District will annex and serve some areas where wells are dry.	Some wells going dry.	More shallow wells will probably go dry.
Yolo	Ground water wells going dry.	More deep wells.	None	May recharge aquifiers from gravel pit water.
North Bay Area				
Sonoma County Water Agency	Lake Mendocino, Lake Pillsbury, ground water	Supplies adequate, capacity not adequate	Cut agricultural deliveries from pipeline: some rationing in effect.	Many communities will be short this summer: rationing prevalent.
Marin Municipal Water District	32,000 acre-feet (0.04 km^3), 50% of capacity from 5 local reservoirs; need 25% use reduction.	Severe rationing; use of water-saving devices.	Rationing.	Lack of fall rains could be even more serious.
San Joaquin Valley				
Foothill Areas	Wells	None	None	Some wells are expected to go dry.
Twain Harte	Inadequate storage	Encourage voluntary conservation	None	None
Sky Acres Mutual Water Co.	Ground Water: inadequate surface storage.	Curtail water use	Unknown	Unknown
Mariposa	500 acre-feet (0.0006 km^3) reservoir	Drill 2 new wells	None	None

TABLE 4 (Continued)

Municipal and Industrial Water Supply Problem Areas
1976 Water Year

Project/Area or City	Supply/Demand	Water Management Operational Strategy	Impacts on Users: Problems/Actions to date (5/1/76)	Impacts on Users: Expected Problems/Actions
<u>Central Coastal</u>				
City of Santa Cruz	7 percent shortage	Conservation program	Water use has been cut 10 percent by a voluntary conservation program.	May have rationing.

The City of Sacramento is prepared to reactivate wells, if necessary. Some efforts to encourage residents to use water wisely have been initiated, but the absence of meters makes significant conservation unlikely.

The more serious problems are occurring in the foothills and mountain communities, where wells are becoming dry or the ground water supply from wells is doubtful because the water system operators have had no experience with the system in a very dry year. In some cases, small local reservoirs have not filled.

In Shasta County, shallow wells in the Churn Creek Bottom area are already becoming dry. In addition, springs in the foothill areas and some shallow wells near Enterprise are expected to become dry this summer. Clear Creek Community Services District has been asked to annex and serve adjacent areas where wells are failing. The district has a firm supply from the U. S. Bureau of Reclamation.

The main concern in Butte County centers on the foothill communities, subdivisions, and rural areas which do not have a proven water supply. Paradise, north of Oroville, and Magalia have already declared an emergency situation and adopted conservation measures. The districts serving the cities have contracted with Pacific Gas and Electric Company to purchase supplemental water. The only other agency known to actively promote conservation is the California Water Service Company, which serves Chico, Hamilton City, and several other communities in the Sacramento Valley. The company has prepared printed material promoting water conservation measures that it encloses with its bills to customers. Communities without firm water supplies which are or may be in serious trouble are Swede's Flat, Bald Rock, Bangor, Berry Creek, Feather Falls, and Cherokee. Water for fire fighting is an ever present problem that will undoubtedly worsen.

In Quincy, the problem is the low reservoir levels. Early in May the Quincy Water Company instituted rationing to limit lawn watering.

The City of Lakeport expects a possible shortage to occur during late 1976. Conservation measures are not being seriously considered yet. A few years ago, when a water shortage was expected, moderate conservation measures were instituted; the result was an increase in per capita water use.

In the north San Francisco Bay area several serious water supply problems exist this year. Many communities are served by the Sonoma County Water Agency. Late spring rains provided an adequate supply, but delivery capacity is limited and will remain so until a new pipeline is completed in 1977. The agency reports that water supply in its two reservoirs has been increased by runoff in the last few months. Lake Mendocino (Coyote Dam) now holds 85,000 acre-feet (0.105 cubic kilometre), and Lake Pillsbury, 75,000 acre-feet (0.093 cubic kilometre). The agency expects to maintain flows of 125 cubic feet per second (3.5 cubic metres per second) into the Russian River, which should provide adequate water for fish, recreation, agricultural, and domestic use, and can furnish some water to the Marin Municipal Water District to help alleviate its critical shortage.

The Sonoma County Water Agency also reports that the transmission facilities limit the amount of water that it can supply to many outlying water users, including Santa Rosa, Cotati, Petaluma and Rohnert Park. Petaluma has already initiated mandatory rationing, with a portion of the town east of the freeway watering lawns on odd-numbered days and the western portion of town, on even-numbered days. The City of Santa Rosa will put all wells in production and does not plan to ration water; however, it anticipates a water quality problem, primarily because of the iron and manganese in several wells that would normally not be used. Cotati has recently completed several new wells but will implement some water rationing. Since there was rationing last year, the residents are extremely cooperative. The nearby city of Sebastopol relies entirely on a ground water supply, and no problems are anticipated.

The Marin Municipal Water District obtains water supplies from five local reservoirs having a combined capacity of 63,000 acre-feet (0.078 cubic kilometres). They are about 50 percent full at the present time, and the district has begun mandatory rationing. The district estimates that it must reduce water consumption at least 25 percent to stretch the supply through December 1. At present it plans on continuing rationing through the year until it has determined that there will be sufficient runoff to alleviate the situation. The district will place a bond issue before the voters this fall to build a reservoir on Walker Creek that would be constructed in stages as the demand increases.

In the Central Coastal Area, three inches of precipitation in April in the Santa Cruz area helped considerably and increased stream flows by 15 percent in the streams and the San Lorenzo River. This permitted a diversion of 100 acre-feet (0.00012 cubic kilometre) from Felton Diversion to Loch Lomond Reservoir near Santa Cruz. A net deficiency of about 400 acre-feet (0.00048 cubic kilometre) existed at the end of April in the City of Santa Cruz system. A 7 percent deficiency estimated to last throughout the summer months could result in a 15 to 20 percent shortage during a peak day.

A water conservation program using the mail, radio, and television has been initiated. Voluntary cooperation by water users has already produced a 10 percent reduction in use. Plans for mandatory rationing have not been put into action.

In the San Joaquin Valley, communities on the valley floor which obtain supplies from major ground water areas are not expected to have problems. The foothill areas, however, present a different picture. A number of water company operators commented that homes dependent on private wells would probably experience some difficulty.

Twain Harte plans to encourage voluntary conservation this year. Sufficient amounts of water are available from Pacific Gas and Electric Company, but more storage is needed. Other foothill water companies and public agencies reported no anticipated problems this year. They serve the following communities: Sonora, Groveland, Wofford Heights, Oakhurst, and Bass Lake Heights. Sky Acres Mutual Water Company near Oakhurst in the foothills has one good well to serve about 60 residences, but it is curtailing water use as a precautionary measure because of inadequate regulatory storage. Mariposa has a 500-acre-foot (0.0006-cubic-kilometre) reservoir which failed to fill this year. To meet the community demand, it will drill two wells.

Recreation

Despite the drought, many lakes and reservoirs in California will provide very good recreation for boaters, picnickers, campers, and swimmers this summer. However, some water supply reservoirs will be drawn down below boat ramps and improved beaches late in the summer. Some agencies are planning to compensate for low water levels to extend existing ramps. The State Division of Parks and Recreation foresees no major problems with water supply at state parks this summer. Low-flow shower heads have been installed throughout the system, along with other water-saving devices.

Among the waterways and reservoirs which will provide normal recreational opportunities are the large afterbays below major water supply reservoirs, including Thermalito, below Lake Oroville; O'Neill, below San Luis Reservoir; and Whiskeytown, near Redding. Lake Tahoe and the Sacramento-San Joaquin Delta will also provide good recreational opportunities.

The rapid drawdown of many water supply reservoirs to very low stages will begin in early summer, leaving some boat ramps and recreation facilities far above the waterline at Shasta, Oroville, Folsom, and San Luis Reservoirs. However, the latter three will have at least one boat ramp operating all season.

At Shasta six major ramps are located at 1,004 feet or higher. All ramps are expected to be high above the water by mid-May. The U. S. Forest Service is currently attempting to meet the demand for recreational boat launching by providing temporary facilities. In about mid-May the Forest Service will initiate a recreational "hot line" to handle public inquiries. Those calling (916) 246-5338 or (916) 246-5339 will receive a two-minute message on water conditions and the overall recreational outlook at both Shasta and Clair Engle Lakes.

Table 5, "Recreation Potential at Reservoirs - Summer 1976", evaluates recreation at the more heavily used recreation areas. Dry-year fire dangers may close even those lakes which are expected to have enough water for recreation.

TABLE 5

Recreation Potential at Reservoirs - Summer 1976

Area/Reservoir	Expected Lake Levels	Recreation Potential
North Coast		
Clair Engle (Trinity)	Will drop 30 feet (9.1 metres) from mid-June through mid-September.	The Trinity Center boat ramp will be out of water near the end of August. According to the U. S. Forest Forest, Service Stewart Fork will be usable until approximately August 5; Tannery Gulch, until August 15; Estrellita, until August 10; Trinity Center, until September 1; and Fair View and Cedar Stock should be good for the balance of the season. See text.
Lake Mendocino (Coyote Dam)	Will drop faster than in normal years.	Boat ramp will be out of water by late August. Memorial Day levels are fine for boating and the swimming beach. Probably not usable on Labor Day.
San Francisco Bay Area		
Marin Municipal Water District Lakes	Will lower steadily through the summer.	One of the five lakes will go dry but use of four will be possible.
Chabot	Will remain at normal levels.	Fishing and boating will continue through the summer.
San Pablo	Level very low.	Down for dam studies. No recreation this year.
Central Coast		
Loch Lomond	Already at 51% full, going down.	Loch Lomond Park will be closed about the second week in July.
San Antonio Reservoir	Will be held high this year.	Good recreation.

TABLE 5 (Continued)

Recreation Potential at Reservoirs - Summer 1976

Area/Reservoir	Expected Lake Levels	Recreation Potential
Nacimiento Reservoir	Level will go down to 711 feet.	There will be a long, narrow strip of water without boat access to side channels. Expect only 20-25% of normal use due to low level.
<u>Southern California</u>		
Cachuma	About 10 feet (3 metres) below normal now; no projection.	Recreation is expected to be near normal this year.
Casitas	Now at 218,000 acre-feet (0.27km^3); will go down to 203,000 acre-feet (0.25 km^3).	Boat ramps presently inoperable, but plans are to extend. Other recreational impact expected to be minimal.
Lake Piru	Will be drawn down for maintenance.	Reservoir will be closed this year.
Pyramid	Will hold at present level.	Normal recreation; ramp usable all summer.
Castaic	Will remain near 1,492 feet through summer.	Normal recreation; ramps usable all season.
Perris	Will remain at present level.	Normal recreation; ramps usable all season.
Elsinore	Present level is 1,230 feet, level dependent on evaporation and reliability of supply wells.	Boat ramp goes to 1,227 feet. Call for current conditions: 714-674-4115 (or 3005).
Silverwood	Will vary between 1,333 and 1,353 feet.	Recreation normal, ramp operable all season.
El Capitan	Near last year's level.	Fishing is the primary activity.

TABLE 5 (Continued)

Recreation Potential at Reservoirs - Summer 1976

Area/Reservoir	Expected Lake Levels	Recreation Potential
Colorado River Basin		
Lakes Powell, Mead, Mojave, and Havasu	Lakes at or above last year.	All recreation activity is expected to be normal. Call the National Park Service for information at (602) 645-2471.
Lahontan Area		
Eagle Lake	Level good.	No boat ramp problem this season.
Stampede	Will be at low levels early in season.	The boat ramp will be dry by mid-June; the reservoir will go below minimum recreation pool. There is a new campground, and recent stocking has made fishing good.
Boca	Levels not affected very much this year.	Boat ramps should be usable throughout the season.
Donner	Will fill.	Recreation will be normal all season.
Tahoe	Now at 6,226.8, will go to 6,226.1 in July, 6,225.5 in August, 6224.9 in September and 6,224.4 in October.	With a lake level drop of 4 feet during the season, some problems with boat docking. Other recreation will be normal. El Dorado Beach ramp under construction. Kings Beach Ramp will operate all season.
Prosser	Levels will recede early and drop to minimum storage.	The boat ramp will be above water in early June, and the lake will be drained for a rough fish kill and subsequent restocking. Virtually no recreation in late summer.

TABLE 5 (Continued)

Recreation Potential at Reservoirs - Summer 1976

Area/Reservoir	Expected Lake Levels	Recreation Potential
Central Valley		
Shasta	Will recede steadily to 900 feet in the fall.	All ramps will be out of water in late May, but some will be extended. See text.
Whiskeytown	Normal water levels.	All recreation normal all season.
Lake Alamanor	Will drop from 4,471 in May to 4,467 in October.	Most boat ramps already out of water. Plumas Pines ramp still usable in May.
Oroville	Will lower during the summer to a low of 740 feet in October.	Springtown, Dark Canyon, Vinton Gulch, and Nelson Bar ramps already inoperable. Enterprise will be dry about June 1; Bidwell Canyon, about August 1; Loafer Creek and Lime Saddle, about September 1; in October, when the lake is at its lowest expected level, only the spillway ramp will be in operation.
Thermalito	No level change.	Recreation normal.
Lake Davis	Will remain within 6 feet (1.8 metres) of spillway.	No problems expected.
Frenchman	Now at 5,565 feet; will go to 5,552 feet.	Boat ramp inoperable most of summer.
Antelope	Steady drawdown beginning June 15 to 400 acre-feet (0.0005 km^3) by September.	Lake will be drawn down for a rough fish kill next winter and subsequent restocking. This summer recreation will be marginal.

TABLE 5 (Continued)

Recreation Potential at Reservoirs - Summer 1976

Area/Reservoir	Expected Lake Levels	Recreation Potential
New Bullards Bar	Level low, will recede to minimum in October.	Dark Day boat ramp usable until July.
Camp Far West	Recede to 175 feet (dead storage) by September 1.	Boat ramps will be usable. Lake edges will be muddy.
French Meadows	Lower than 1975.	Both ramps already out of water; expected to be extended this year.
Hell Hole	Will go down to 4,482 in October.	Boat ramp will probably be unusable by mid-June.
Union Valley	Will not fill, low levels, down to 4,723 feet in October.	Boat ramp barely usable now, not available after July 1. Public can call (916) 622-5061 for information.
Loon Lake	Down to 6,366 feet in October.	Boat ramp usable until late summer.
French Lake, Sawmill, Jackson Lake	Dry by July 1.	No recreation after July 1.
Jackson Meadows	Will go down to 5,978 feet by October.	Boat ramp expected to be usable.
Clear Lake	Level is low, will evaporate to 1/2-foot below "zero" by fall.	Lakeside Park ramp usable all season.
Black Butte	At minimum storage by October.	Public can call (916) 440-2327 for information.
East Park and Stony Gorge	At minimum storage by June 1.	No recreation this year.

TABLE 5 (Continued)

Recreation Potential at Reservoirs - Summer 1976

Area/Reservoir	Expected Lake Levels	Recreation Potential
Folsom	Level now low, will recede steadily to about 390 feet in October.	Granite Bay Ramp Stages #3 and #4 already dry, Peninsula now marginal. Granite Bay #2, Rattlesnake Bar, and Brown's Ravine may be dry by the end of June. Granite Bay Stage #1 and the 5% Ramp will be usable through mid to late August. Dike 8 ramp usable through September.
Berryessa	Down to 1,000,000 acre-feet (1.23 km^3) by October.	Recreation expected to be normal. Public can call (707) 966-2111 for information.
Pardee	Levels will be low.	Low water levels expected throughout the summer will detract from recreation. Boat ramps will be extended with temporary landing mats. Public can call (209) 772-1325 for information.
Comanche	Levels will recede during summer.	Information available by calling (209) 763-5178.
New Hogan		Current information will be available at (916) 440-2327
Don Pedro	To 710 feet by October 1, 1976	Recreation expected to be good. Information available at (209) 852-2369 (Don Pedro Marina).
Lake McClure	Projected to a low of 729 feet.	At 750 feet the permanent ramps begin to be out of water. Two portable ramps at Barret Cove and McClure Point allow launching down to 700 feet. Information available at (209) 378-2711.
Tulloch	To 431 feet in October.	Recreation fishing all season.

TABLE 5 (Continued)

Recreation Potential at Reservoirs - Summer 1976

Area/Reservoir	Expected Lake Levels	Recreation Potential
Millerton (Friant Dam)	Minimum storage by early August, 472 feet.	Large ramp operable to 464 feet. Most ramps operable all year. Current information available at (209) 822-2332.
San Luis	Will draw down to low of about 410 feet.	Boat ramp operable to 326 feet. Call (209) 826-1196 for information.
O'Neill Forebay	Stable water level.	Ramps operable. Good recreation.
Pine Flat	Will go down to 731 feet.	Even at lowest elevation, two of the four ramps will be operating. Good through Labor Day. Call (916) 440-2327 for information.
Terminus	Down to minimum pool in August.	Recreation normal.
Success	Minimum recreation pool at 583 feet.	Fishing and small boats operable down to minimum recreation pool. Call (916) 440-2327 for information.
Isabella	Expected minimum elevation to be 2,538 feet.	Boating ramps at Peninsala and Old Isabella Road usable. Recreation expected to be normal.
Buena Vista Aquatic Recreation Area.	Stable water level.	Good recreation.

In the North Coast Area, recreation at Clair Engle Reservoir will be good, with ramps operating through mid-August. A new ramp is planned for completion late this year at Pole Gulch to 2,300 feet. The Trinity Center ramp will be extended when water levels permit. Lake Mendocino ramps will be above the water by late August.

In the San Francisco Bay area, the Bay itself will, of course, support normal use. The Marin County reservoirs will be low, but only one is expected to be dry. Lake Chabot above San Leandro will be available for boating and fishing, but San Pablo Reservoir will not be usable this year.

In the Central Coastal Area, Loch Lomond Reservoir will close about mid-July. However, normal recreation use is expected at San Antonio Reservoir, on a tributary of the Salinas River. Nacimiento Reservoir, also on a tributary of the Salinas River, will be drawn down with fewer recreation opportunities expected this season.

In Southern California, all reservoirs are reported to be expecting normal recreation opportunities this year, except Lake Piru, which will be closed for maintenance work, and Casitas Reservoir, where ramps are presently inoperative. The ramps are planned to be extended.

The Colorado River reservoirs are all at or above last year's very high levels. All recreation activity is expected to be normal in reservoirs and on the river itself.

On the Nevada side of the Sierra Nevada, Eagle, Boca, Donner, and Tahoe lakes should sustain normal recreation all year. A low lake level at Stampede may limit recreation.

In the Sacramento Valley portion of the Central Valley, good recreation is expected all season at Whiskeytown Reservoir, Thermalito Afterbay, Clear Lake and Berryessa Reservoir, with early season recreation satisfactory at many other reservoirs.

In the San Joaquin Valley portion of the Central Valley, good recreation is expected at Don Pedro Reservoir, O'Neill Forebay, Lake Isabella, Lake McClure, Millerton Lake, Pine Flat, San Luis Reservoir, and Buena Vista Aquatic Recreation Area.

Whitewater boating and river floating and rafting are fast-growing recreation activities in California. Low river levels are causing most of the commercial operators to change their type of craft this year from large 10-man rafts to smaller rafts or to "Tahiti" or "Parawa" inflatable kayaks. Commercial outfitters expect some degree of financial loss from the low water this year; one of them estimated a possible 40 percent decrease in revenues as compared to last year. Many are receiving more reservations than last year but find that clients are interested in different streams this year. Many favorite runs are on streams sustained by water releases from power operations. The Department of Water Resources makes a recorded telephone message available for the entire season at (916) 322-3327 (Sacramento) to provide information on major whitewater and rafting streams.

Fish and Wildlife

Under natural conditions, fish and wildlife species exhibit a great ability to survive the climatic variations experienced in their environment. Adverse weather, and water quantity and quality problems have an effect on the food supply, shelter, reproduction, survival of young and maintenance of adult populations, but survival of the species is rarely in question. However, when species are stressed or reduced to marginal habitat conditions, the survival of the species or its various subpopulations is in jeopardy.

Some rare and endangered species have been the sources of great concern during this dry year in California because of their restricted habitat. Some desert species were causing particular concern early in the year, but the spring rains there have alleviated that problem. The bighorn sheep depend on flowing springs, which are now available. The pupfishes, which live in a few desert ponds, are also no longer in danger because their water supply is assured for this year.

In the Central Valley, the food supply of the San Joaquin kit fox and Fresno kangaroo rat will be reduced and the population may decrease slightly. The Modoc sucker, the rough sculpin, the Lost River sucker, and the shortnose sucker will suffer some losses. The Santa Cruz long-toed salamander will experience low rates of reproduction, but, since they are long-lived, there should be no lasting effect on their population.

Fishermen will not notice the effect of the dry year on anadromous fish until maturing adults return to spawn in two to four years. Survival of very small striped bass in the Sacramento-San Joaquin Delta will be in the lower range of the past few years, due to low Delta outflows. Some effect will carry over for several years. Shad, which spawn in the main Sacramento River and its larger tributaries, will be affected by the lower flows in the spring and summer months, which will reduce nursery capacity. King salmon fishermen are expected to detect a minor change in these fish because most of them originate in the Sacramento River system, and the species depends less on Delta conditions than do striped bass and shad. Little impact is expected on Central Valley steelhead because the bulk of the population is supported by hatchery operations.

The dry year is expected to have little effect upon silver salmon and steelhead populations in streams from northern Mendocino County northward; a significant portion of the juvenile populations of these species may be lost in streams from southern Mendocino County southward because of severely restricted summer flows.

Trout in streams will be affected in marginal habitats that exist chiefly at lower elevations. Low flows and warmer water temperatures will cause trout to move to higher elevations, if migration is possible. At higher elevations, trout can survive in the deeper pools, even if streamflow becomes very low. Good trout angling at lower elevations will be confined to the early part of the season. Many of the marginal trout waters will become too warm or may become dry. Good angling will continue longer at higher elevations where waters are cooler. Late summer flows will be occurring in most streams by mid-June; fishing will therefore be difficult in July and August. Many smaller streams will probably stop flowing by August, and trout will be confined to scattered pools.

Reservoir fisheries will be less affected, except in those reservoirs which are significantly drawn down. Low tributary inflow to all reservoirs may adversely affect trout spawning above the reservoirs. Bass, sunfish, and catfish spawn during the April-June period. Some reservoir drawdown will begin during this period and will uncover the spawning areas. A loss of reproduction is expected where this occurs. Conditions will be complicated by the lower water volume and subsequent increased exposure of the young fish to predators.

Populations of bass, sunfish, and catfish in drawndown reservoirs will not provide good angling because they are reduced by lowered food production, excessive water temperature near the shoreline, and reduced oxygen. The shoreline is also less inviting to the fisherman. Brood bass react to the stress of the in-lake water level fluctuations, temperature, and dissolved oxygen. These conditions will inhibit reproduction and thus will result in fewer fish in subsequent years. Lowered reservoir levels, along with the problems outlined above, will mean fewer catchables planted for put-and-take operations. Regional offices of the Department of Fish and Game should be contacted for further information on planting programs this summer.

Water quality problems may be encountered in Shasta and Camanche reservoirs because of lower-than-normal dilution of toxic copper-zinc levels. Reduced late summer releases could affect fish in the reservoirs and streams below. Small natural ponds and dredger ponds are drying up in some areas, reducing sunfish and catfish angling opportunities.

Upland game will suffer to some degree from lack of normal forage and available water supply in the inner coastal range and Central Valley. Deer reproduction is expected to be lower than normal at lower elevations where fawning cover will be sparse. Lower production of quail may be expected in both the desert and in the Central Valley in the locations where the light rainfall has stunted the usual cover. In the northeastern part of the State, reproduction of sage grouse and chukar partridge may decline because of light forage and cover. The long-term effects of reproduction losses are not expected to be serious.

Normal waterfowl habitat on the west side of the San Joaquin Valley and in the bypass system of the Sacramento Valley may not be as large as normal, due to the unavailability of water. Water for the San Joaquin Valley portion of the habitat usually comes from the Bureau of Reclamation's Central Valley Project. Water for habitat in the Sacramento River bypass system is usually available from river and stream overflows and winter rains.

Energy

Reduced amounts of precipitation during the 1976 water year will cut hydroelectric generation in California to about 50 percent of normal. The estimated amount of hydroelectric energy in 1976 is 15.6 billion kilowatthours, compared to a normal year generation of 32.6 billion kilowatthours. Approximately 28 million barrels of oil would be required by steam generating plants to replace the 17.0 billion kilowatthours reduction in hydroelectric generation.

Fortunately, water conditions in the Pacific Northwest have permitted the hydroelectric generation of more electrical energy than is needed in that region. By using the high voltage transmission line interconnections between the Pacific Northwest and California, approximately 14 billion kWh of surplus electrical energy will be available to the electric utilities in California during the year. This is 8 billion kWh more energy than California was expecting. In November 1975, it was estimated that California would receive 6 billion kWh over the intertie lines. This additional power will reduce the impact of the cost of reduced hydroelectric generation in California and will also decrease the effect on air quality of additional generation by oil-fired generating plants.

It is interesting to compare the effect of the present water conditions on hydroelectric generation with the situation that developed during the 1947-48 period. The water year 1946-47 was very dry, and precipitation from November 1947 through March 1948 was about 50 percent of normal. As a result, nonessential uses of electricity in Northern California had to be curtailed until the drought was broken by substantial precipitation during April and May, 1948. The State was more dependent on an adequate supply of water during those years because at that time hydroelectric plants accounted for about 60 percent of the total generating capacity. About 20 percent of the total capacity is produced by hydroelectric plants today. Moreover, large amounts of hydroelectric energy could not be imported to California in 1947 and 1948, as is done now. Other factors which contributed to the earlier power shortage were the high rate of load growth following World War II and the difficulty of constructing generating capacity during the war.

Wildland Management

Even in years of normal rainfall, California is unique throughout the world in experiencing large, destructive wildfires. If the intensity of brush and timber fires that have occurred already is any indication, this year could be one of the most disastrous in recent years in terms of fire damage to life, property, and natural resources.

The State Division of Forestry is expecting fires that are more intense and spread more rapidly than normal, especially fires that are fed by heavy vegetation, such as timber. And, even though the drought has produced little grass in the wildlands, there is still enough to carry fire rapidly toward heavy vegetative fuels. Actual damage will, of course, depend upon several unpredictable factors: (1) the cooperation of the general public in reducing the number of wildfires; (2) the occurrence of critical fire weather, especially of drying north and east winds; and (3) the ability of fire suppression forces to control most fires before they can develop into major conflagrations.

Effects of Drought on Fire Behavior

Wildland fires spread principally through vegetation, both living and dead. The rate at which they spread and the intensity with which they burn depend to a large extent on the dryness of that vegetation.

In a normal year, the living parts of brush have a moisture content of 120-175 percent at this time of year. The vegetation gradually dries through the long, hot summer to reach a moisture content of 60-70 percent in the late summer and fall. This year's drought has already resulted in a moisture content as low as 62 percent in the leaves and twigs of manzanita and chamise in Calaveras County. This low level is less than that reached in the driest part of the fire season in many years.

Also, in a normal year, the dead vegetation is just beginning to dry out in May; it now will ignite and burn readily. First, the annual grasses die and become flammable. Then the twigs and branches of trees and brush that litter the ground become dry. Finally, the larger limbs, logs, slash, and fallen trees that have soaked up moisture from snow and rain throughout the winter gradually dry and add to the intensity of any fire burning through them.

This year the dead fuels are already very dry, for the most part. The snow level has remained high in the mountains, and the large, dead fuels have been uncovered much earlier than usual. Fires are already occurring in timbered areas that normally would not burn until July or August.

The Division of Forestry and other wildland fire protection agencies must take special measures this year to alleviate the potential destruction. This effort will require the assistance of all Californians and others who visit the State's wildlands, if the challenge is to be met successfully. More than anything else, the rise in the number of fires occurring in the wildlands each year must be reduced.

Measures That Are Being Taken

To achieve its overall goal, the Division of Forestry is alerting the public to the extraordinary fire danger, strengthening its cooperative efforts with other agencies, and training more auxiliary sources of fire-fighting assistance.

Here are some of the measures already being taken by the Division of Forestry throughout the State:

1. State fire crews and year-round personnel are being used more widely than ever before to inspect homes and other property in the wildlands for compliance with state laws related to reducing fire hazards.

2. More intensive programs for educating the public have been initiated with the news media. The newspaper and TV and radio stations have been highly cooperative in broadcasting this year's fire danger.

3. The assistance of local organizations, service groups, and the news media is being enlisted to implement the Division's "Red Flag Program", an intensified special effort to alert the public locally during the most critical periods of fire weather.

4. The division is increasing its usual work with public utilities, road departments, and railroad companies to reduce the hazard of wildland fuels along their rights of way.

5. The use of fire-retarding chemicals to treat roadside vegetation is being tested in a few critical areas to reduce the start of a number of fires there.

6. The State Forester is considering the declaration of hazardous fire areas in a few locations where public use may have to be restricted.

7. Mutual assistance agreements with other agencies, fire departments, and private industry are being reviewed and strengthened.

8. Training is being given to a greater number of auxiliary wildland firefighters, including volunteer fire departments, community college students and county employees.

9. Training is also being given by at least one Ranger Unit to members of the Civil Air Patrol in methods of detecting and reporting wildfires during periods of critical fire weather.

10. The Division is inventorying, more carefully and completely than in most years, the availability of mobile water tankers from ranches, construction companies, road departments, and other sources. The drought has either dried up many of the usual sources of water -- such as streams, reservoirs, and privately owned wells -- or has left them so low that they are barely adequate to serve domestic needs.

The start of the fire season has had to be declared earlier than usual in several parts of the State. The Central Coast Region was placed on fire season status on May 1; the Lake-Napa Ranger Unit, on May 5; the Nevada-Yuba-Placer, Shasta-Trinity, Butte, and Tehama-Glenn Ranger Units, on May 10; and the South Sierra Region, on May 11. The fire season was declared throughout the remainder of the State by May 17, 1976.

The Division of Forestry is taking a number of steps to augment its fire protection system to meet the extraordinary conditions that exist.

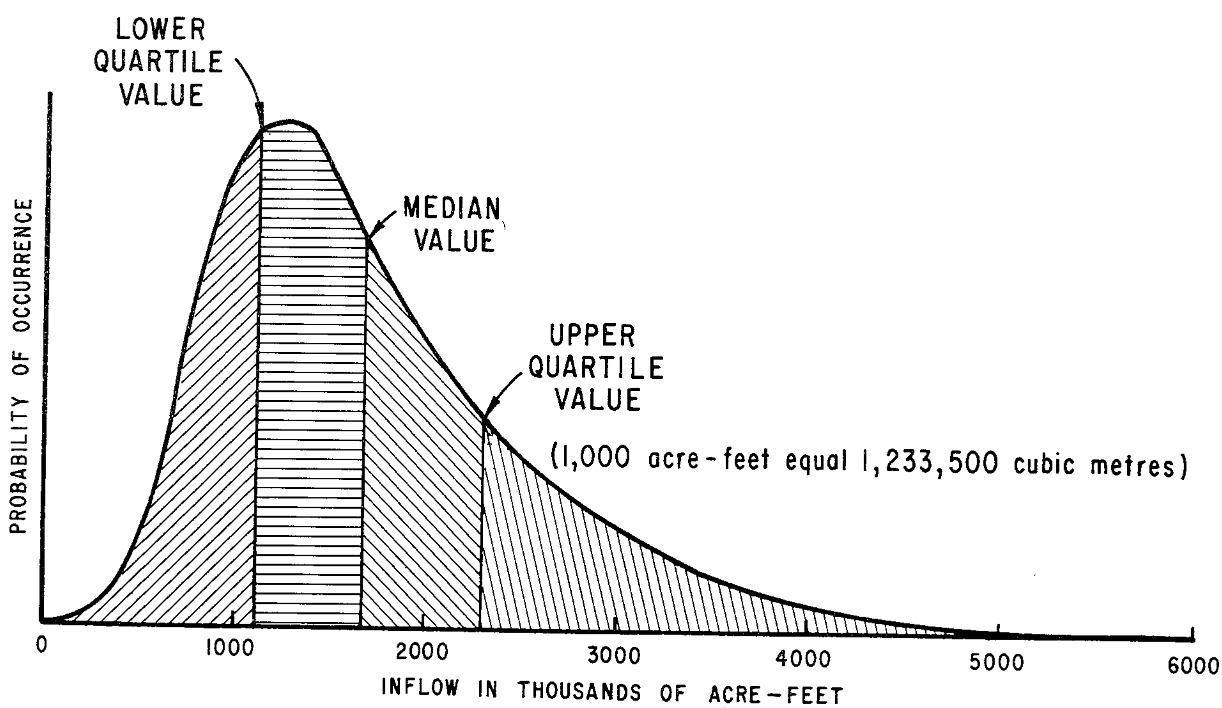
The drought may also adversely affect forest trees by making them more susceptible to damage from insects and disease. The lack of available moisture weakens the trees and reduces their natural ability to reject infestation. During the current year, the Division of Forestry expects to spend more public money than usual in assisting forest landowners to meet the cost of fighting epidemics of insects and disease in forest trees.

WHAT IF 1977 IS ALSO DRY?

In planning their strategies for 1976, water management agencies need to know what 1977 may hold. Some assurance that 1977 will be normal or above normal would allow all available water to be used in 1976. But if 1977 turns out to be a below-normal year, saving some water in storage might be the better strategy. Some skill in long-range weather forecasting a year in advance would be of great value. Such skill has not been developed, although some experimentation is underway, including Hydrospect II, here in California. It is a research program that is testing techniques of long-range weather forecasting. The program is supported by Kern County Water Agency, Friant Water Users Association, Tulare County Flood Control District, Kaweah Delta Water Conservation District, Kings River Conservation District, and the U. S. Bureau of Reclamation, and is managed by the Department of Water Resources. It was started in 1975. The forecasts are made by scientists at Scripps Institution of Oceanography at three-month intervals for a full year in advance. It is too early to judge the accuracy of these forecasts.

Chances of a Dry 1977

The distribution of hydrologic values historically gives us a picture of the chance of such values occurring in the future. The probability of occurrence of unimpaired inflow to Millerton Lake (Friant Dam) on the San Joaquin River is illustrated by the following graph.



UNIMPAIRED INFLOW TO MILLERTON LAKE

The lower quartile value of flow, as shown on the graph, represents about 1,100,000 acre-feet (1.35 cubic kilometres) of inflow for the year. The area under the curve to the left of the lower quartile value represents the probability of the occurrence of that amount of inflow, or less, in any year. Since that area makes up one-fourth of the total area under the curve, there is one chance in four that the inflow will be the lower quartile value, or less.

The median (near average) annual inflow is about 1,700,000 acre-feet (2.08 cubic kilometres), and half the area under the curve is on the drier side of the median value and half is on the wetter side of the median value. Consequently, there is one chance in two that inflow will be less than the median value, and one chance in two that it will be greater. The curve indicates that there are about two chances in three that inflow will be near normal or above normal in 1977, or in any other year.

Because the watersheds will be very dry next fall, and because each year's streamflow is influenced by how wet the preceding year was, there is slightly less than a 50-50 chance that runoff will be the median value when precipitation is at the median value. However, to simplify the evaluation of possible impacts in 1977, both precipitation and runoff (or reservoir inflow) are assumed to be median for a normal year and lower quartile for a dry year.

A benefit of this dry 1976, which we will realize in 1977, is greater-than-normal flood protection, at least for the early part of the 1977 season. Because of the large drawdowns, the levels of many large reservoirs will be below normal flood control storage and thus able to store more storm water.

State Water Project - Central Valley Project - The Delta

Project operations in 1977, for the Central Valley and State Water Projects will, of course, be dependent upon the water supply received during the winter of 1976-77. The following paragraphs indicate the effect of this supply on each project.

State Water Project

A median supply to California during 1976-77 would permit the State Water Project to completely recover from the effects of the 1976 dry year. Lake Oroville would be essentially filled and provide normal carryover storage into 1978. Power contracts would be met, water quality requirements in the Delta would be met, and entitlement and all requested surplus water could be delivered.

With a lower quartile water supply during 1977, the State would meet its share of Delta water quality requirements, meet entitlement deliveries, and deliver up to 300,000 acre-feet (0.370 cubic kilometre) of surplus water. Lake Oroville would fill to about 2.8 million acre-feet (3.454 cubic kilometres), or about the level achieved in 1976, and be drawn down to about 1.6 million acre-feet (1.974 cubic kilometres) in the fall. Again power commitments would be met. Reservoirs along the California Aqueduct would contain about 500,000 acre-feet (0.617 cubic kilometres) of carryover storage.

In discussing the 1976 impacts, it was stated that planning for State Water Project operations in 1976 took into account the possibility that 1977 will also be a dry year equal in severity to 1931. In that event, the State Water Project deliveries for 1977 would be limited to firm contract entitlements totaling about 1.6 million acre-feet (1.974 cubic kilometres), Delta water quality criteria would be met, but no surplus water would be available. Entitlement deliveries, by agency, as developed for Bulletin No. 132-75, "State Water Project in 1975", are shown in Table 6. Reservoir storage in aqueduct reservoirs at the end of 1977 would be about equal to the level planned for the beginning of the year, assuming that 1978 would also be as dry as 1931.

The State Water Resources Control Board on April 29, 1976 held a hearing concerning revisions in the water quality control plan for the Sacramento-San Joaquin River Delta and Suisun Bay. The Department of Water Resources statement at the hearing said in part "At present, the fish and wildlife criteria for the western Delta are the controlling standards as to minimum outflow from the Delta. We propose that these standards be reviewed from the point of view of the anticipated runoff during the upcoming water year. Our recommendation involves a relaxation of these standards in drier years and increased outflow requirements in wetter years. The recommended standards are designed to maintain the Bay-Delta fishery at least at recent historic levels".

If the Central Valley Project is not able to meet its share of outflow to provide necessary conditions in the Delta (D-1379-State Water Quality Standards) further reductions in State Water Project deliveries would be required[a]. It should be pointed out that the Bureau of Reclamation has voluntarily met these requirements thus far in 1976.

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[a] Under conditions of a 1931 water supply, the State Water Project would have to impose a full 50 percent deficiency on agricultural users, about 300,000 acre-feet (0.370 cubic kilometre) and would still have sufficient water to meet Delta water requirements. With a lower quartile water supply, State Water Project deliveries would be limited to entitlement amounts.

TABLE 6

STATE WATER PROJECT ENTITLEMENTS DELIVERIES - 1977*
in Acre-Feet**

Agency		Area Totals
Butte County	1,050	
Plumas County	620 p	
Yuba City	0	1,670
Napa County	0	
Solano County	0	0
Alameda County Flood Control and Water Conservation District Zone 7	18,400	
Alameda County WD	22,200	
Santa Clara	88,000	128,600
Devil's Den WD	12,700	
Dudley Ridge WD	30,400	
Empire West Side ID	3,000	
Hacienda WD	4,200	
Kern County WA	483,600	
Kings County	1,700	
Oak Flat WD	3,700	
Tulare Lake Basin	54,800	594,100

Agency		Area Totals
Antelope Valley-East Kern WA	50,000	
Castaic Lake WA	0	
Coachella Valley	8,420 p	
Crestline-Lake Arrowhead	1,231	
Desert WA	13,000	
Littlerock Creek ID	730	
Metropolitan WD	754,179	
(East Branch)	557,979	
(West Branch)	196,200	
Mojave WA	0	
Palmdale WD	100	
San Bernardino	57,500	
San Gabriel	10,000	
San Gorgonio	0	
Ventura County	0	895,160
San Luis Obispo	0	
Santa Barbara	0	0
Total, All Deliveries		1,619,530

* Based on Bulletin No. 132-75 data, assumes State Water Project meets only its share of D-1379 Requirements.
**One acre-foot = 1.233×10^{-6} cubic kilometres.

p = projected amount

Central Valley Project

A median supply in the winter of 1976-77 would also mitigate the difficulties imposed by the dry year on the Central Valley Project. The U. S. Bureau of Reclamation estimates it could meet all water contracts, all power commitments, and provide its share of the water needed to meet Delta water quality criteria. In addition, there would be substantial recovery of storage in Shasta, Clair Engle, and Folsom Lakes.

With a lower quartile supply in 1976-77, the U. S. Bureau of Reclamation anticipates the Central Valley Project would be about 1,300,000 acre-feet (1.604 cubic kilometres) short of the supply necessary to meet commitments. While all power commitments would be met, no interim water would be available and a 25 percent deficiency would be imposed on all water contracts. In addition, the sum of the storages at Shasta, Folsom, and Clair Engle Lakes would decrease. Depending on the degree of dryness, the Bureau would face difficulty in meeting a portion of its share of requirements for water quality in the Delta.

Using the assumption that 1977 will be a dry year equal in severity to 1931, the U. S. Bureau of Reclamation would expect a water supply equal to about 40 percent of average. The Bureau would expect to impose the maximum 25 percent deficiency on all water rights contracts, and a 40 percent deficiency on all other water contracts. No interim water would be available. The Central Valley Project could meet a portion of its share of water quality requirements in the Delta.[a] It would also encounter problems in meeting its power contracts. Storage in Shasta and Clair Engle Lakes would be reduced to about 500,000 acre-feet (0.617 cubic kilometre, each, while storage in Folsom Lake would be reduced to about 200,000 acre-feet (0.247 cubic kilometre).

Agricultural Areas

Dry-Farmed Areas

Fortunately, this dry year will have little effect on next winter's dry-farmed grain. Rangeland, however, may suffer due to the lack of seed setting and over grazing of the 1976 limited forage. A lower quartile precipitation year would produce more forage than did 1976, but another year as dry as 1976 would compound the plight of cattle ranchers, sheep producers, and some dairy operators. Hay and feed prices, already high because of

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[a] For effect on State Water Project see discussion on State Water Project.

the dry 1976, could go even higher, making it necessary to further reduce animal populations. Such a situation in 1864 in Southern California actually spelled the doom of beef cattle as a major industry there.

Irrigated Areas

Water project operators are, for the most part, using all available water in their reservoirs for irrigation in 1976, leaving most reservoirs at dead storage in the fall of 1976. Exceptions are the Central Valley Project, State Water Project System, the Colorado River reservoirs, Don Pedro and McClure Reservoirs in the San Joaquin Valley, and San Antonio and Nacimiento Reservoirs in the Salinas Valley.

If next year produces a median water supply, irrigation needs will be met, from all systems, but deliberate ground water recharge will be small. If 1977 is in a lower quartile year, problems similar but not as severe as in 1976 will occur. A very dry 1977, similar to 1976, would compound the ground water problems already being felt this year. However, the increased ground water pumping capacity developed in 1976 would be helpful in meeting water requirements.

The State Department of Food and Agriculture observes that continuation of the drought in 1977 would cause complex and serious problems for the State's agricultural industry. The Department states:

> "Such an event would cause severe dislocations of cropping plans and the ancillary economic relationships. For example, the rice crop in California is subject to planting allotments allocated by committees acting under the aegis of the USDA. A shortage of water might inevitably require a reduction in rice acreage. This would cause not only consternation to the farmers involved, but would also have an inevitable adverse effect on the incomes of those companies and individuals in California dependent on rice production activities as well as conceivably affecting the international movement of rice. The same would, of course, be true for cotton, sugar beets, alfalfa, etc., which are dependent on substantial quantities of water applied at critical stages of growth. The whole interwoven fabric of agricultural production, marketing, and consumption is involved and could be severely affected by a continuation of adverse rainfall conditions. As usual, the consumer would again be asked to pay the price responding to an unbalanced supply-demand ratio for goods over whose production he has no control."

Urban Areas

The communities having water supply problems this year would experience similar conditions next year if a lower quartile year should occur. Having adjusted to 1976, they are likely to more readily accept rationing and conservation programs in 1977. Marin Municipal Water District has developed a contingency plan for a dry 1977, involving attempts to obtain water from other agencies. A median year would appear to solve problems for everyone.

Recreation

A median water supply in 1977 would return recreation to normal in all locations. A lower quartile year would involve situations similar to 1976, and would provide even better conditions than in 1976 at some of the larger reservoirs which are experiencing less than lower quartile inflow this year.

Fish and Wildlife

A median year should cause no problems for any species. A lower quartile year would extend the effects on the sport fisherman to three to four years, instead of the two-to-three-year carryover effect from the 1976 drought. The impact on trout fishery would, however, be even more severe than in 1976. Many of the upland birds and game, and the endangered species depend on forage produced by rainfall, and they would suffer from the lack of forage and cover. However, reproduction in most species depends on spring rains, and even if the year is dry, spring rains, rather than fall and winter rains, could ameliorate the effects.

Energy

A median year would permit production of near-normal amounts of hydroelectric energy. Lower quartile water conditions during the 1977 water year would be more favorable for hydroelectric generation than in the 1976 water year. Approximately 23 billion kWh could be generated by hydroelectric plants in the State which would be 70 percent of normal. The reduction from normal generation would require a power source equivalent to the energy derived from burning 17 million barrels of oil in steam generating plants. This amount could be reduced if surplus energy is again available in the Pacific Northwest for use in California.

Wildland Management

A median 1977 would bring forest management back to a normal situation. But if fires in the summer and fall of 1976 burn more than the usual number of acres of protective vegetative cover, then erosion of wildland soils during the winter of 1976-77 could create severe problems downslope and downstream. Siltation could impair or destroy habitat of anadromous fisheries. Deposition of soil, rocks, and debris in reservoirs and lakes could result in huge expense to remove that material. Sedimentation could destroy many valuable acres of agricultural land, fill the culverts and drainage ditches of roads, and destroy homes and other property situated on natural flood plains.

A second year of drought could produce an even more damaging fire season in California's wildlands. Even more important, the potential effects of a second dry year on weakened trees in the forest could be devastating. Damage to trees from insect and disease epidemics in 1977 could be as much as four times that which will be experienced in 1976.

POSSIBLE ALTERNATIVE STRATEGIES FOR 1976 and 1977

The impacts of a critically dry year on economic, environmental, and social values are significant. With each year a severe drought continues, the effects become more pronounced, and both financial and stored water reserves are further depleted. With the present level of meteorologic knowledge, forecasts having any degree of reliability cannot be prepared for more than a few days in advance. It is, therefore, essential that each water supply agency develop contingency plans to cope with the eventuality of a dry 1977 and also of a drought of an intensity and duration equal to the worst drought that has occurred in its service area.

The experience gained in earlier droughts is not a good indicator of the impacts of the current drought in California because the population and irrigated lands of the State have increased dramatically. Population was 5.7 million in 1930; it is now over 21 million. During this period, irrigated land increased from 4.2 million acres (1.70 million hectares) to almost 9 million acres (3.64 million hectares). Irrigated agriculture water use now represents about 85 percent of the fresh water use in California.

Each water supply system has its unique mix of limitations, commitments to customers, financial arrangements for staff and physical works, and general public safety and welfare considerations. Therefore, specific strategies to cope with drought conditions must be tailored to the individual requirements of the agency. The use of water for domestic purposes in the highest priority use and agricultural irrigation use is next highest (Water Code Section 106). All uses must be reasonable and beneficial.

The following suggestions are offered as a planning strategy to assist an agency in analyzing its present situation and in developing contingency plans to cover the possibility that 1977 will also be dry and the more remote possibility that 1976 may be the first of several dry years that could equal the record critical drought period for the area.

Urban Areas

Only so much water can be saved by the water supply agency; it is the people who use the water that will ultimately reduce water usage. The community must be involved. A water supply agency for a specific urban service area would have several factors to evaluate. The following itemization lists typical processes involved in identifying the problem, the impact of the problem on the community and the agency, alternative solutions, the consequences of carrying out the solutions, the risks involved, and special considerations.

Water Supply Assessment

This step involves assessing the availability of water for the current year. Answers to the following questions will indicate possible supply alternatives:

1. Is supplemental water available from other sources not normally used or not fully used?

2. If next year were to equal the current year, should there be any holdover of current year water supply? Is there any supplemental water that could be quickly developed or contracted for to augment the local supply?

3. Is there a source of good quality treated waste water in the service area?

4. Are there any legal or institutional constraints on the availability of the regular water supply or the possible supplemental sources? Will basin water quality control plans be affected?

Water Needs Assessment

This step involves classifying water service commitments by type of use: residential, industrial (by its special requirements), fire protection, municipal irrigation (parks, landscaping, golf courses, etc.), private golf courses, and agricultural uses (by crop).

Total demands for water should be estimated.

Priorities of water use should be estimated by types of use: public health and safety, community welfare, economic well-being, environmental value, and luxury uses (landscaping, lawns, street washing, golf courses, and other similar uses).

Supply - Demand Evaluation

This step involves comparing water service demands with anticipated water supply and identifying any supply deficiencies or surpluses, monthly and annually, at least, for the critical period.

Operation procedures and distribution system flexibilities should be investigated to determine whether any surplus water can be carried over into subsequent periods, if needed. If any surpluses are not needed by the agency, other agencies or agricultural lands within the general area that need the water should be identified.

The magnitude and frequencies of any deficiencies will indicate the immediate drought problem faced by the water supply agency.

Drought Strategies

This step involves comparing the magnitude of water deficiencies with the water demands by priority of use categories. If the deficiencies of supply can be compensated for by small reductions in noncritical water uses, then one usable strategy has been identified. If only very minor reductions in all water uses would compensate for the deficiencies, then another strategy has been identified. If reclaimed waste water can be used for public landscaping or other compatible uses, then additional fresh water could be made available. If surplus water from some other agency can physically and institutionally be obtained within the time contraints, this would be another alternative.

The supply and distribution system should be thoroughly inspected for leaks and wastage. Any repairs possible to prevent leakage should be made immediately and operational procedures should be developed as quickly as possible to prevent waste.

A communication program should be put in operation as soon as the problem is identified to keep the general public informed and to solicit possible recommendations for solutions. An education program on ways to reduce water use should be implemented as quickly as possible and continued during the critical period.

A citizens advisory panel could be established to provide assistance and recommendations for development of solutions and dissemination of information on water saving schemes. Local public service groups should be encouraged to participate.

Recommendations on watering of home landscaping for best plant growth with a minimum amount of water should be sent out with the water bill to all customers. Information on ways to conserve water within the home should also be distributed.

Water pricing policies should be revised to provide incentives to reduce water use. This could be a system whereby quantities of water in excess of minimum requirements are priced considerably higher (referred to as an increasing block rate) and discounts to large water users should be eliminated. Water price increases may also be necessary to maintain the financial integrity of the water agency during a period when less than normal water is sold.

A kit of water saving devices that could be easily installed should be made available to all customers free, if feasible, or otherwise at cost. It could include items such as shower head inserts to reduce water flow, special low-flow aerators for lavatory and kitchen faucets, and plastic bottles to put in toilet tanks to reduce flush volume, and other devices for this purpose that are commercially available. A door-to-door voluntary installation plan could be prepared.

In a critical situation, rationing to ensure equitable distribution of supplies may be necessary. A good enforcement of such regulations is essential for public support and to maintain credibility of the agency.

Resources

Several organizations and publications can be of assistance in developing solutions to save water. A few are listed below:

- Department of Water Resources Bulletin No. 198, "Water Conservation in California", May 1976. Findings and recommendations from Bulletin No. 198 are reproduced in Appendix C of this report.
- California Water Resources Center, University of California/Davis, Report No. 35, "Residential Water Conservation", by Murray Milne, March 1976.
- Staff of the four District Offices of the Department of Water Resources in Red Bluff, Sacramento, Fresno, and Los Angeles. Addresses and telephone numbers are listed in Appendix B.

Agricultural Service Areas

Irrigated agricultural service areas present a somewhat different situation from the urban areas. Problem assessment and strategies for coping with a deficient water supply usually occur at two levels. Each farmer must assess his or her particular situation and plan the yearly cropping pattern on an understanding of one's share of the water supply. The irrigation district or water supply agency must base its planning on the summation of water demands of each farmer and the institutional and legal frameworks under which it operates, together with the water supply that is available and any alternative supplies that may be readily obtainable. Inasmuch as the farming operators have had considerable experience in working with water supplies that vary from year-to-year due to the natural hydrologic regimen, a dry year represents an extreme but not completely unexpected occurrence.

The typical dry land farmer has only a few alternatives in case of a drought and is frequently limited to replanting in late spring, if he or she believes there will be enough late spring rain to germinate and mature the second crop. If the fields have been prepared for irrigation and there is an available water supply, one can resort to irrigation. However, in the typical dry-farm areas of California, an irrigation water supply is not available, and the fields have not been prepared for its application.

The unirrigated grazing lands represent a similar situation, and the usual option in the event of a drought is to sell the livestock early when the grass is gone. At this stage, the animals usually have not experienced much weight gain and the situation results in a financial loss. The only other alternative is to buy feed for stock, an option which may not be profitable.

The irrigated farming situation would typically be based on the conditions for each farm. One's share of the water supply would depend upon the priority of one's water rights or the rights of one's water supplier and the nature of one's membership in the agency. Alternative sources of water may also be available.

Once the water supply has been estimated for the growing season, the farmer can then plan a cropping pattern. The strategy can consist of one of the following alternatives, a mix of two or more, or some similar option when the supply is less than normal:

1. Reduce the overall acreage of crops.

2. Change all or part of the acreage to crops that use less water.

3. Reduce the amount of applied water for salt leaching and allow a temporary minor buildup of salt in the soil. Additional water for leaching would be required in subsequent years in areas receiving less than 14 inches (346 millimetres) of rainfall.

4. Increase the efficiency in water application.

5. For tree crops, apply only enough water to ensure survival of the trees and suffer a reduction or loss of crop.

6. Reduce or eliminate annual crops and use available water for the tree crops.

7. Where feasible, increase use of ground water in place of surface supplies.

8. Apply less than normal water to some crops such as alfalfa. Although some production would be lost there would still be some yield.

Several of the above options can have other consequences, and other farmers may be affected. For example, if one farmer applies water more efficiently or uses less water than normal, the next farmer downstream on the drainage ditch or river channel may have considerably less water than would normally be expected. Reduced return flows or prevention of seepage from distribution ditches could reduce the growth of brush and weeds in some areas that may make up important wildlife habitat.

Many of the strategies for coping with a drought emergency in agriculture are also strategies for general water conservation that permit agriculture to function efficiently with lower water supply expectations. The Department's recent Bulletin No. 198, "Water Conservation in California", contains a summary of most of the means to save water in irrigation, as well as some of the problems and trade-offs that can be involved. Findings and conclusions from Bulletion No. 198 are reproduced in Appendix C.

The Department and the University of California Cooperative Extension Service are planning a jointly sponsored conference on Agricultural Water Conservation, to be held on June 23-24 this year. The topics on the agenda are pertinent to a drought situation, as well as to long-range plans to save water in the agricultural sector. Items on the agenda include:

- Where and how much water can be saved.
- Energy, environmental, and economic aspects of water conservation.
- Technical methods for increasing irrigation efficiency and their relative suitability under various field conditions.
- Possibilities for water savings through improved water delivery system design and operation.
- Impact of water pricing on the rate of water use.
- Legal and institutional ways to implement conservation.
- Practical considerations in implementing water conservation on the farm.

Advisory resources available include private firms that provide services related to farm and irrigation management and the following Public agencies:

University of California Cooperative Extension Service.

Regional Office of the U. S. Bureau of Reclamation.

U. S. Soil Conservation Service.

District Offices of the Department of Water Resources.

Addresses and telephone numbers are listed in Appendix B.

Alternative Regional and Statewide Water Management Strategies

The preceding discussion emphasized that the individual farmer and city resident can save the most water. Water suppliers have an obligation to make sure that their water supply systems are operating efficiently with an absolute minimum of leakage and wastage. Water service agencies are responsible for communicating to residents the local ramifications of the drought on the availability of water in the service area. Water service agencies can also instruct water users in ways to save water in the service area and establish emergency regulations to ensure equitable distribution of water, including rationing, if conditions warrant.

Previous sections of this report noted that variations in the hydrologic regimen of the State and the development of water resources within local areas produce a wide range of differing drought impacts. Some areas may have a full supply to meet their needs, while other areas may have critical shortages. Under the appropriative water rights doctrine, one farmer with an early water right may receive his normal water supply, while a late appropriator on the same river may receive no usable water. Within the Central Valley, the water storage projects of the major water development agencies have ameliorated the situation for agriculture and urban areas to a large extent by providing seasonal regulation and carry-over storage of runoff. However, lack of conveyance systems makes it physically impossible to get water to some areas, even within the Central Valley.

On a statewide or regional basis, the available developed water resource has sufficient inherent flexibility to ease the impact on some water-deficient areas, if the next year or years are also dry, without visiting undue hardships or risks on those entitled by water rights or legal arrangements to the water supply. Some of these strategies are outlined in the following discussion. Implementation of any one of these would require complex institutional arrangements, and economic, legal, and physical constraints may be insurmountable within the time available. The situation is further complicated because having a good water supply during a drought constitutes an economic advantage and foregoing this advantage by sharing the water supply with others can represent an economic loss to those who have made the commitment and exercised foresight by planning and by investing their capital to obtain the firm water supply.

Colorado River Water Exchange

The Metropolitan Water District of Southern California and its member agencies have a water supply consisting of several components. The ground water basins of the South Coastal Area of California have been developed by member agencies of Metropolitan Water District of Southern California to their safe yield capability and the utility of some basins has been expanded through artificial recharge with reclaimed waste water and surface water supplies. Most of the available surface water has been developed in the area. The City of Los Angeles, one of the member agencies has an imported water supply from the Mono Lake-Owens Valley area. The Metropolitan Water District has water rights to Colorado River water, and imports from this source are an important component of the water supply. The district will lose a portion of its Colorado River supplies when the Bureau of Reclamation's Central Arizona Project is completed in the mid-1980s. Until that time the district could, by using its existing conveyance capacity, continue to use its former entitlement water. The district is also a major contractor for State Water Project supplies.

The district could operate its Colorado River Aqueduct to its full capacity during 1977, while cutting back on its importation of State Water Project water. The State Water Project could then hold the district's entitlement water in storage in San Luis Reservoir for use in 1978, if that year is also dry. An alternative to storing the water in San Luis would be to store the State Water Project deliveries in ground water basins in Southern California for use in later dry years.

Some of the many factors to be evaluated for a plan of this nature are:

° Costs to the District, its member agencies, and the State Water Project, and a determination of which party meets these costs.

° Power requirements would be complex. It would take less energy but cost more to convey the Colorado River water, and some energy could be foregone from the Colorado River hydroelectric power generation system. Long-term commitments have been made for capacity and there may be no reduction possible in capacity requirements.

° Water quality impacts would have to be considered. Colorado River water is much higher in total dissolved solids and hardness.

° Operational problems or benefits for both the District system and the State Water Project system would have to be studied.

° Contractual constraints would require consideration.

° Legal constraints and water rights considerations would require examination.

Ground Water

Most of the ground water basins of the South Coastal Area are operated to balance withdrawals and replenishment over the long term. Considerable amounts of additional extractable water stored in the ground water basins could be borrowed temporarily. In some ground water basins a risk of permanent damage such as surface subsidence, sea-water intrusion, or other physical effects would preclude their consideration for even a temporary mining plan. Others would require additional wells and modification of existing wells to allow pumping at lower levels. Some basins would not have adequate recharge zones to artificially replace the water.

There would still be some basins where greater than normal ground water extractions might be physically possible with a minimum level of risk. For these basins, the water agencies could pump greater than normal amounts of ground water next year, if it is also a very dry year, and cut back on their demands for imported State Water Project water supplies for which they have contractual entitlements in their own right or as a member agency of the Metropolitan Water District of Southern California. The reduction in demand for State Water Project entitlement water could then make the water available in San Luis Reservoir to hold over in the event the State is in a long-term drought or to meet other current project requirements. When normal runoff occurs in the future, additional water would be exported to Southern California to replenish the ground water basins, subject to limitations of aqueduct capacity and power availability.

All the factors listed under "Colorado River Water Exchange" would need to be carefully covered, as well as the specific ground water geologic, hydrologic, and institutional considerations.

Use of Ground Water In Lieu Of Surface Water

On the east side of the San Joaquin Valley, some major irrigation water agencies use stored water from the Stanislaus, Tuolumne, and Merced Rivers. Within the service areas of these water agencies are ground water basins that could probably be used extensively, at least for a short period, without any major permanent detrimental effects on the ground water basins. Many domestic wells would go dry, however.

If these agencies could use ground water during the drought and release the water stored in the reservoirs directly to the Delta, the total availability of usable water supply within the Central Valley would be increased. Many new wells would probably be required, and electrical energy would have to be made available to pump the water. Some changes in the local distribution systems might be required so that the irrigators can use the ground water instead of surface water supplies.

Several complex factors would need to be evaluated and solutions negotiated between the parties involved for any problems encountered. Some of the factors and problems are itemized below:

° Physical capability of the ground water basin to produce the water and the long-term effects on the basin of such usage.

° Capability of the well drilling industry to develop the wells.

° Availability of pumps and motors for the wells.

° Revisions required in distribution systems and the capability to construct any necessary modifications.

° Determination of incremental costs and who pays such costs.

° Protection of the water rights of the local agencies.

° Control of the water while it is conveyed in the lower San Joaquin River to prevent unauthorized diversions of the water by the local water users.

° Energy requirements, costs, and availability.

A similar potential for ground water use exists within some areas of the Sacramento Valley, South San Francisco Bay Area, and possibly in the San Luis Service Area. Problems and evaluations similar to those itemized in the above discussion of the San Joaquin Valley would be involved.

Crop Reduction

The water supply in the Sacramento Valley might be extended temporarily to other beneficial uses in a critically dry year or drought period by cutting back high water-use crops that are not essential to the immediate food and fiber needs of the nation. Normally large acreages (300,000 to 500,000 acres, or 0.121 to 0.202 million hectares) of rice are planted each year. Rice is a major export crop to the world market.

If contractual arrangements could be developed to greatly reduce the acreage of rice in a critically dry year, then a major augmentation of the water supply of the Sacramento Valley for other uses could be realized. Compensation to the rice growers and possibly to the entire rice industry and those affected by the rice industry might be required. Social impacts of this procedure, as well as local economic impacts, might be extensive, and detailed evaluation of all factors would be required. Institutional arrangements to carry out this activity would be very complex. Many different parties would be involved, and equity for those affected would be difficult to assess. One important factor needing consideration would be the effect on international relations and world food supply. However, the quantity of water that could be obtained would be quite large. A reduction of 100,000 acres (40 500 hectares) in rice planting, for example, would reduce consumptive use of water 330,000 acre-feet (0.407 cubic kilometres) which would be available for other uses.

Time for evaluations and negotiations would probably not be sufficient to carry out a procedure of this nature during the current drought situation. It could be a strategy for future droughts, if the arrangements were made well in advance of need.

Coordination of Central Valley Project-State Water Project

The Central Valley Project and the State Water Project are currently being operated in a coordinated fashion, with frequent joint discussions of strategies to make the optimum use of the available supplies and capabilities of both systems. This coordination is discussed earlier in this report. Special studies and situation evaluations will continue throughout the dry period to meet contractual commitments by the most efficient means possible. It is, therefore, not useful here to discuss potential alternative strategies.

Other Strategies

Much can be done by the individual farmer and resident to conserve water, and water agencies have a responsibility for efficient system operation, communication, and education. Statewide water management strategies can assist in interbasin balancing of water supplies. However, to complete the picture of possible strategies for the current drought and potential future droughts, some additional concepts will be discussed.

Evaporation Suppression

Water evaporates from the surface of all water bodies, and the rate of evaporation depends on such factors as temperature, wind, and humidity. Typical evaporation rates in the Central Valley vary from 5 to 6 feet (1.5 to 1.8 metres) of water depth and can be as high as 8 feet (2.4 metres) of water depth in the Colorado Desert. If this loss could be suppressed or greatly reduced, substantial quantities of water could be saved.

Coverings on small water storage facilities can be effective in suppressing evaporation but are obviously not practical for large bodies of water. Some chemicals or chemical compounds, such as acetyl alcohol form a very thin film (as thin as one molecule thick), on the water surface and reduce the evaporation rate. However, wind and wave action break up the film, reducing its effectiveness. If they are not washed up on the shore or blown away by winds, some of the chemicals can reform a film on the water surface. Such chemical films can be effective for small water bodies, and some are commercially available. Before any are used, their limitations must be determined for specific sites and their effect on water quality determined.

Floating panels and plastic blankets are also commercially available to control evaporation and to reduce heat loss from the water body. On small water bodies, these can be effective, but on larger bodies of water, wind and waves reduce their utility.

Evaporation control offers an opportunity to save water and additional research and development of techniques and materials are probably justified to make it more practical.

Anti-Transpirants

Some research has been done on chemical compounds to reduce the transpiration rate of plant leaves in hot weather. Apparently some plants transpire more water from their leaves than is essential for healthy plant growth and crop production. Several anti-transpirants are commercially available. The effects vary from improved fruit quality to damaged plants and poor quality fruit. If continuing research is productive, this may be a useful water conservation technique for both normal and dry years.

Information for the Future

The State has grown dramatically in population, economic development, and in total use of water since the previous major drought of the early 1930s. Thus, the impact of the current dry year, and especially of any subsequent dry years, should be recorded. Strategies used by the various water supply agencies, as well as individual water users, should be evaluated as to effectiveness, environmental impact, economic consequences, and problems encountered. Public reaction and cooperation in emergency conservation programs should be surveyed as part of the evaluation of effectiveness of various strategies.

Information of this type, together with data on the hydrology and operation of projects, will provide a useful information base for use in planning strategies to cope with future droughts.

Legal and Institutional Considerations

Water rights doctrines and institutional arrangements to provide water service have evolved over the entire life of the State of California. Negotiated settlements, court actions, legislation, and even physical violence have all played a role. A water supply represents a vested interest, and changes in legal and institutional conventions will have a beneficial impact on some, while working a hardship on others. While changes may be difficult and time consuming, they may also increase the flexibilities in water resource management and help minimize the detrimental impacts of droughts. It is probably not possible to implement a strategy involving major changes in legal or institutional factors for the current drought. The following discussion briefly covers a strategy that could be valuable in future droughts.

Where one area has a critical water shortage and an adjacent area has surplus water, much of the problem of maldistribution of developed water supplies stems from the constraints imposed by water rights doctrines and institutional conditions of public and private water supply agencies. This situation contrasts with the functioning of electric utilities, where the private companies and public utilities maintain their separate economic identities but, through extensive interties of power distribution lines and cooperative agreements, a shortage in one service area can be quickly balanced by power generation in another system.

Water laws and institutions should be evaluated to determine means of obtaining agreements for temporary interchange of water supplies to meet system failures and drought deficiencies, and to optimize the development and distribution of water. If the institutional arrangements can be made, then it would be feasible to plan for the physical interconnection of water supply systems.

While the foregoing discussion may appear to cover only surface water supplies, from a total water resource viewpoint, the concept must also include the ground water resource. Fullest use of the total water system requires the conjunctive development of surface water and ground water. Optimum development can only be attained when the ground water basins are considered as water reservoirs. When surplus surface water is available, artificial recharge of the ground water basins can be accomplished with over-irrigation or winter-irrigation through projects specifically designed for the deep percolation of the surplus water.

APPENDIX A

Definitions of Terms

The table below displays the type of data from which median and lower quartile values are obtained. The values derived here are also shown in Figure 1 of the text of this report. The terms "median value" and "lower quartile value" are defined on the following page.

Observed Precipitation at Sacramento, California

Rank	Amount	Year	Rank	Amount	Year	Rank	Amount	Year
1	33.80	1890	34	19.76	1937	67	14.87	1949
2	32.27	1886	35	19.54	1951	68	14.76	1957
3	31.94	1958	36	18.74	1965	69	14.31	1950
4	31.83	1941	37	18.55	1975	70	14.16	1922
5	27.74	1956	38	18.33	1953	71	13.97	1887
6	27.14	1973	39	18.29	1916	72	13.91	1946
7	26.58	1952	40	18.11	1883	73	13.62	1930
8	26.57	1881	41	17.86	1879	74	12.95	1917
9	26.47	1880	42	17.75	1927	75	12.57	1932
10	26.09	1967	43	17.71	1970	76	12.28	1960
11	25.66	1969	44	17.70	1925	77	12.20	1908
12	25.07	1940	45	17.58	1944	78	12.18	1910
13	24.94	1942	46	17.42	1971	79	12.04	1961
14	24.87	1878	47	17.32	1897	80	11.60	1928
15	24.83	1938	48	17.27	1902	81	11.59	1947
16	24.78	1884	49	17.20	1915	82	11.58	1966
17	24.11	1895	50	17.20	1919	83	11.58	1934
18	24.04	1907	51	17.06	1945	84	11.56	1888
19	23.95	1893	52	16.92	1955	85	11.17	1968
20	23.93	1906	53	16.87	1904	86	11.04	1964
21	23.23	1896	54	16.80	1921	87	10.61	1918
22	22.83	1974	55	16.62	1903	88	10.51	1898
23	22.28	1963	56	16.58	1885	89	10.46	1959
24	21.98	1911	57	16.51	1882	90	10.39	1929
25	21.98	1905	58	16.35	1894	91	10.34	1972
26	21.78	1909	59	16.05	1926	92	9.74	1939
27	21.10	1935	60	15.81	1891	93	9.55	1912
28	20.53	1936	61	15.69	1923	94	8.90	1920
29	20.44	1914	62	15.54	1954	95	8.43	1931
30	20.24	1900	63	15.44	1948	96	8.12	1933
31	20.21	1901	64	15.26	1962	97	8.03	1913
32	19.98	1943	65	15.18	1892	98	7.99	1924
33	19.95	1889	66	15.04	1899			

Median value = 17.20"

Lower quartile value = 12.95"

Median value. The middle value, when the data are placed in descending order. When the list of data has an odd number of points, the median value is the middle number in the list. When the list has an even number of points, the two middle numbers are averaged to obtain the median value.

Lower quartile value. The value that lies one-fourth the distance from the bottom of data placed in descending order. When this point falls between two numbers, the numbers are averaged to obtain the lower quartile value.

Class I water. That supply of water at Friant Dam and Reservoir which will be made available for delivery from the Friant-Kern Canal, Madera Canal, or the San Joaquin River as a dependable water supply during each irrigation season. When the water supply is less than the firm supply, the shortage is apportioned.

Class II water. That supply of water which becomes available in addition to the supply of Class I water and which, because of its uncertainty as to availability and time of occurrence, will be undependable in character.

Surplus water. That portion of available State Water Project water that exceeds the total of annual entitlements of all contractors for the year, after appropriate allowance for holdover storage.

Unimpaired runoff. Streamflow at any station that would have occurred under natural conditions, unaltered by upstream diversions, storage developments, or by exportation or importation of water to or from other watersheds.

Interim water. That portion of the Central Valley Project yield which is dedicated to future projects.

APPENDIX B

Sources of Information on Water Conservation and Management

University of California Cooperative Agricultural Extension Service

ALAMEDA COUNTY

F. Gordon Winlow, County Director
224 West Winton Avenue, Room 162
Hayward CA 94544

(415) 357-0844 (North)
881-6341 (South)

AMADOR COUNTY

Robert E. Plaister, County Director
114 Main Street, Room A
Jackson CA 95642

(209) 223-0151

BUTTE COUNTY

Alva W. Mitchell
2279 Del Oro Avenue, Suite B
Oroville CA 95965

(916) 534-4201

CALAVERAS COUNTY

Daniel M. Irving
30 Main Street
San Andreas CA 95249

(209) 754-4160 or 754-3213

COLUSA COUNTY

Thomas M. Aldrich
747 Fremont Street
Colusa CA 95932

(916) 458-2105

CONTRA COSTA COUNTY

J. Joseph Coony
960 East Street
Pittsburg CA 94565

(415) 439-8282, ext. 201
or 682-8601; 757-7535

DEL NORTE COUNTY

John V. Lenz
Court House Annex, 981 H Street
Crescent City CA 95531

(707) 464-4711

EL DORADO COUNTY

D. Barry Leeson
311 Fair Lane
Placerville CA 95667

(916) 626-2468

FRESNO COUNTY

Kenneth W. Ellis
1720 South Maple Avenue
Fresno CA 93702

(209) 488-3000

GLENN COUNTY

Stephen P. Carlson
Road 200 East
Orland CA 95963

(916) 865-4487

HUMBOLDT-DEL NORTE COUNTIES

John V. Lenz
Ag. Center Bldg.
5630 South Broadway
Eureka CA 95501

(707) 443-0896

IMPERIAL COUNTY

Adolph F. Van Maren
Court House, 939 Main Street
El Centro CA 92243

(714) 352-3510, ext. 210
(night) 352-3614

INYO-MONO COUNTIES

P. Dean Smith
207 West South Street
Bishop CA 93514

(714) 873-5891, ext. 2

KERN COUNTY

John O. Hoyt
2610 "M" Street
Bakersfield CA 93303

(805) 861-2631

KINGS COUNTY

George V. Ferry
310 - 11-1/2 Avenue
Hanford CA 93230

(209) 582-3211

LAKE COUNTY

Chester L. Hemstreet
883 Lakeport Boulevard
Lakeport CA 95453

(707) 263-3051

LASSEN COUNTY

Carl W. Rimbey
Memorial Building
Susanville CA 96130

(916) 257-5506 or 257-5505

LOS ANGELES COUNTY

Donald O. Rosedale
155 West Washington Boulevard
Room 606
Los Angeles CA 90015

(213) 749-6911, ext. 820

MADERA COUNTY

Wm. R. Hambleton
128 Madera Avenue
Madera CA 93637

(209) 674-4641, ext. 236

MARIN COUNTY

Donald L. Brittsan
Marin County Civic Center, Room 422
San Rafael CA 94903

(415) 479-1100, ext. 2374

MARIPOSA COUNTY

John P. Anderson
Fairgrounds
Mariposa CA 95338

(209) 966-2417

MENDOCINO COUNTY

Wm. H. Brooks, III
579 Low Gap Road, County Ag. Center
Ukiah CA 95482

(707) 462-4731, ext. 276; 277

MERCED COUNTY

Glenn H. Voskull
240 West 17th Street
Merced CA 95340

(209) 726-7404

MODOC COUNTY

Cecil D. Pierce
202 West 4th Street
Alturas CA 96101

(916) 233-2123

MONTEREY COUNTY

J. William Huffman
118 Wilgart Way
Salinas CA 93901

(408) 758-4637

NAPA COUNTY

Dean R. Donaldson
1436 Polk Street
Napa CA 94558

(707) 253-4211

NEVADA COUNTY

William E. Mason
255 South Auburn Street
Grass Valley CA 95945

(916) 273-4563

ORANGE COUNTY

Dorothy A. Wenck
1000 South Harbor Boulevard
Anaheim CA 92805

(714) 774-7050

PLACER-NEVADA COUNTIES

William E. Mason
11477 E Avenue
Auburn CA 95603

(916) 823-4581

PLUMAS-SIERRA COUNTIES

Arthur L. Scarlett
Fairgrounds, Route 1, Box 230
Quincy CA 95971

(916) 283-0250

RIVERSIDE COUNTY

Chloe A. Beitler
21150 Box Springs Road
Riverside CA 92507

(714) 683-6491

SACRAMENTO COUNTY

Theodore S. Torngren
4145 Branch Center Road
Sacramento CA 95827

(916) 440-5371

SAN BENITO COUNTY

Edward C. Lydon
Veterans' Building
7th & San Benito
Hollister CA 95023

(408) 627-5346

SAN BERNARDINO COUNTY

George D. Rendell
606 East Mill Street
San Bernardino CA 92415

(714) 383-2768

SAN DIEGO COUNTY

Victor W. Brown
5555 Overland Avenue
Building 4
San Diego CA 92123

(714) 565-5376

SAN FRANCISCO COUNTY

Richard H. Sciaroni
South Hall, Cow Palace
Geneva and Santos Avenue
San Francisco CA 94134

(415) 586-4115

SAN JOAQUIN COUNTY

Win M. Lawson
420 South Wilson Way
Stockton CA 95205

(209) 944-2665

SAN LUIS OBISPO COUNTY

John H. Evans
County Airport, Edna Road
San Luis Obispo CA 93406

(805) 543-1550, ext. 241
(Nights and Holidays) 543-1557

SAN MATEO COUNTY

Richard H. Sciaroni
530 Main Street
Half Moon Bay CA 94019

(415) 726-9059

SANTA BARBARA COUNTY

George E. Goodall
140 East Carrillo Street
Santa Barbara CA 93102

(805) 963-4269

SANTA CLARA COUNTY

Peter J. Lert
215 North First Street
San Jose CA 95113

(408) 299-2635

SANTA CRUZ

Ronald H. Tyler
1432 Freedom Boulevard
Watsonville CA 95076

(408) 724-4734

SHASTA COUNTY

Walter H. Johnson
2430 Hospital Lane, Room 55
Redding CA 96001

(916) 246-5621

SISKIYOU COUNTY

Sedgley D. Nelson
1655 South Main
Yreka CA 96097

(916) 842-2711

SOLANO COUNTY

Arthur K. Swenerton
County Library Building
Fairfield CA 94533

(707) 429-6381

SONOMA COUNTY

Robert L. Sisson
2555 Mendocino Avenue, Room 100-P
Santa Rosa CA 95401

(707) 527-2621

STANISLAUS COUNTY

Armen V. Sarquis
733 County Center III Court
Modesto CA 95355

(209) 526-6654

SUTTER-YUBA COUNTIES

Leonard L. Buschmann
142-A Garden Highway
Yuba City CA 95991

(916) 673-9645

TEHAMA COUNTY

Ronald S. Knight
1135 Lincoln Street
Red Bluff CA 96080

(916) 527-3101

TRINITY COUNTY

Bob L. Willoughby
Court House
Weaverville CA 96093

(916) 623-2361

TULARE COUNTY

Curtis D. Lynn
County Civic Center Ag. Building
Visalia CA 93277

(209) 733-6363

TUOLUMNE COUNTY

Roswell D. Roberts
48 West Yaney Avenue
Sonora CA 95370

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VENTURA COUNTY

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Soil Conservation Service
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California Department of Water Resources

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CENTRAL DISTRICT

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SAN JOAQUIN DISTRICT

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SOUTHERN DISTRICT

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APPENDIX C

Water Conservation Recommendations

The material appearing on the following four pages was originally published in Bulletin No. 198, "Water Conservation in California", which was issued in May 1976.

FINDINGS AND RECOMMENDATIONS

Water-saving opportunities exist throughout the State. Since conditions vary from place to place, specific opportunities must be identified individually. The greatest potential savings are found in areas where significant quantities of return flow from excess water applications are disposed to saline waters without serving further beneficial use. But even in areas where water conservation measures will not save large quantities of water, they may result in energy savings and offer opportunities for environmental improvement through changes in water management.

The following summarizes the findings of this report, presenting water-conservation methods and potential water-savings opportunities, specific actions the Department of Water Resources (DWR) will undertake, and recommendations for actions by others.

Urban Water Conservation

Statewide, urban water use is 68 percent residential, 14 percent commercial and governmental; and 18 percent industrial. Of the residential, about 56 percent is for interior use; most of the remaining 44 percent is used for landscape watering.

Interior Residential Water Savings

The following table indicates the possible statewide residential interior water use savings that might result from various water conservation actions:

POTENTIAL RESIDENTIAL INTERIOR WATER SAVINGS

Feature	Added Cost Per Unit ($)	Water Savings as a % of Interior Use		Potential Year 2000 Statewide Water Savings (1,000 acre-feet)	(Cubic Hectometres)
New Construction:					
● low-flush toilets	0-10	18		185	230
● low-flow showerheads	0-5	12		125	155
● low-flow kitchen & lavatory faucets	0-5	2		20	25
● pressure reducing valves	0-25	5		50	60
● insulated hot water lines	0.50-1.00 per foot of line (1.65 - 3.00 per metre)	4		40	50
● low-water using clothes washers	20-30	5		50	60
● low-water using dish washers	0	4		40	50
			Sub Total	510	630
Existing Housing:					
● plastic bottles or water dams in toilet reservoir	0-6	18		345	425
● replace showerheads with low-flow variety or install flow restrictors	1-5	12		230	285
● place low-flow aerators on kitchen & lavatory faucets or replace entire unit	1-5	2		40	50
● pressure reducing valves	25	5		95	115
● insulated hot water lines	0.50 or more per foot of line (1.65+ per metre)	1		20	25
			Sub Total	730	900
			Total	1240	1530

DWR recommends that:

1. *in all new construction the following be required, either through state legislation or local building code changes:*
   - *low-flow toilets (state legislation enacted in 1976).*
   - *low-flow faucets*
   - *low-flow showers*
   - *pressure reducing valves where line pressure is above 50 psi*
   - *insulated hot water lines;*
2. *local agencies encourage the following to be installed in existing housing, through education programs and by providing the water-saving devices free or at cost:*
   - *weighted plastic bottles, water dams, or other devices in toilet reservoirs to reduce flush-flows*
   - *low-flow showerheads or flow restrictors in the shower line*
   - *low-flow aerators on faucets*
   - *pressure reducing valves where line pressure is greater than 50 psi;*
3. *only low-water-use clothes and dish washers be sold in the State;*
4. *manufacturers of plumbing fixtures and water-using appliances be required to prominently display water use characteristics;*
5. *local governments adopt ordinances that require phasing out of home self-regenerating water softeners and replacement with centrally regenerated units.*

DWR will:

1. *assist local agencies in formulating necessary building and plumbing code changes to require water-saving devices;*
2. *in cooperation with local agencies, develop and submit specific recommendations to the International Association of Plumbing and Mechanical Officials on modifications to the Uniform Plumbing Code regarding requirements for water conservation considerations in the design of fixtures and in other aspects of plumbing.*

Exterior Urban Water Savings

Reduction in outside water use requires more careful landscape watering, i.e., reducing runoff and percolation of water below the roots. Automated sprinkling systems controlled by soil-moisture sensing devices are very effective, but costly. Education on proper watering techniques, followed by a little care on the part of the homeowner, should be all that is needed to make significant savings in some areas (potential water savings vary greatly from place to place). Planting drought-resistant vegetation would also reduce water needs. The public should be informed of the possibility, and nurseries should be encouraged to promote this kind of landscaping. Estimated potential reduction in year 2000 water requirements for landscape watering is 200,000 acre-feet (250 cubic hectometres) per year.

DWR recommends that:

local agencies conduct vigorous programs to reduce exterior water use through public education on lawn and garden watering and low-water using landscape vegetation; establish and enforce irrigation schedules; and provide penalties for gutter flooding or other waste such as excessive use of water for driveway and automobile washing.

DWR will:

encourage the California Association of Nurserymen and similar professional groups to promote the use of low-water-using landscape vegetation.

Urban Water Pricing

To be effective in reducing water use, the cost of water must be made a significant item in the user's budget or operating expenses, and the user must be made aware of the relationship between quantity used and cost. Flat rates and decreasing block rates, both quite common in California, do not do this. The increasing block rate, the peak or seasonal use rate, and to a lesser extent, the uniform rate can, in some cases, accomplish this. In addition, eliminating ad valorem taxes for water and collecting the revenue through the rate structure, and similarly handling sewage treatment charges would further contribute to the user's awareness of the quantity-cost relationships. Attempts to control water use by water pricing must be carefully conceived, to avoid unnecessary or unwanted impacts on the quality of life, on any one segment of society, or on the utility supplier. All basic needs must be met on an equitable basis and prices increased only for that quantity above the minimum required. The lifeline rate system follows this concept.

DWR recommends that:

water agencies use uniform, peak/seasonal, or increasing block rates in water pricing. Where possible, ad valorem taxes for water should be eliminated and sewage treatment costs included in the same billing system. Where appropriate, the lifeline rate concept should be included in the pricing system.

DWR will:

acquire the necessary expertise to provide technical assistance to local water agencies in their efforts to select effective pricing structures.

Urban Water Leakage

Most California water agencies supplying urban water estimate leakage losses to be eight percent or less. Based on the experience of East Bay Municipal Utility District in its concerted effort to detect and close leaks in a portion of its service area, the potential statewide water savings through vigorous leak detection and repair programs would be about 200,000 acre-feet (250 cubic hectometres) per year.

DWR recommends that:

all water agencies institute effective delivery system leak detection programs.

DWR will:

examine the water systems throughout the State and recommend appropriate measures to ensure that actions are taken.

Although there is no basis from which to estimate the potential quantity involved, repair of household leaks appear to offer opportunities for significant water savings. In addition to water loss, hot water leaks also waste energy. While faucet leaks can be detected visually, identifying leaky toilets often require adding dye to the water in the toilet reservoir.

DWR recommends that:

all water agencies promote and assist in the detection and repair of household plumbing leaks.

Commercial and Governmental Water Savings

The means for reducing residential waste of water are also appropriate for the commercial and governmental sector. Implementation of similar measures by commercial and governmental users might save 150,000 to 300,000 acre-feet (185 to 370 cubic hectometres) of water statewide annually at year 2000.

DWR recommends that:

actions recommended for the residential sector also be undertaken in the commercial and governmental sectors.

DWR will:

work with other state agencies to develop water conservation programs at state facilities.

Industrial Water Savings

In the industrial sector, savings are most possible through recycling of water. This already has received a great amount of attention by some industries in their effort to control waste discharges to avoid penalties for contributing to water pollution. Industry, particularly, has benefited from water-pricing systems which favor large water users. Revisions of these systems would encourage additional efforts to reduce freshwater intake.

DWR recommends that:

water-pricing structures that favor large water users be replaced with uniform or increasing block rate structures.

Agricultural Water Conservation

Depending on the circumstances in each case, agricultural irrigation efficiency may be increased by changing to sprinkler or drip systems, improving operation of existing systems (including better irrigation scheduling) and improving other aspects of farm management. Irrigation water use may be reduced by selecting low-water-using crops, and in some cases, by actions to reduce plant consumptive use. Water districts can save water by lining ditches and canals and assist farmers in becoming more efficient by following more effective water delivery schedules. The opportunity for water savings in an area depends on how much outflow is needed to maintain salt balance and the disposition of the excess applied water, i.e., whether it is reused, or disposed of into bodies of saline surface or ground water. Considering these factors and current technology, the approximate reasonably attainable savings of the *current agricultural supply* are estimated to be as follows:

	Acre-Feet	Cubic Hectometres
Central Valley	650,000	800
Colorado Desert	400,000	500
Remaining Areas	150,000	200
Statewide Total	1,200,000	1,500

To accomplish the 650,000 acre-feet (800 cubic hectometres) of savings in the Central Valley, water storage facilities would have to be available (surface and/or ground water storage) to make the quantity saved available when needed for further beneficial use. This total does not reflect the water deficiencies in Tulare Lake Basin resulting from (1) ground water overdraft, and (2) the need to export more irrigation drainage water from the basin to establish a favorable salt balance.

In order to achieve these savings, the need and methods for water conservation and advantages of increased irrigation efficiency must be made known to farmers. In addition, other motivating actions, such as water-price changes, must be taken.

DWR recommends that:

1. *federal and local water agencies strongly promote water conservation in their agricultural water service areas through public education programs. University of California Cooperative Extension Service should cooperate in this;*
2. *farmers be encouraged to plant low-water-using crop to the extent that market conditions allow;*
3. *U.S. Bureau of Reclamation, Soil Conservation Service, and U.C. Cooperative Extension Service expand irrigation advisory services;*
4. *University of California, State Universities, and others step-up irrigation research and demonstration activities;*
5. *research be expanded on means to reduce crop water use (evapotranspiration), including the use of antitransparent chemicals and the allowable soil-moisture deficiency at various stages of plant growth that will not significantly impact crop yields;*
6. *where there are high water table problems, drainage systems be installed to increase crop production per unit volume of water used;*
7. *ditches and canals be lined to eliminate seepage losses, particularly where the water percolates down into saline ground water or contributes to crop production loss due to high water tables.*

Agricultural Water Pricing

Agricultural water prices vary over a wide range throughout the State. In most areas, water costs are a relatively small part of the total cost of operations, and therefore, are not generally an incentive for frugal use of the water. The ability to pay for water varies greatly depending on the crops and the nature of the farm operations. Generally, small farmers have less flexibility to change water use practices in response to price changes than large farmers. In many areas, the price of water is subsidized through power sales, by increased prices to urban users, and through general taxation.

DWR will:

examine water-pricing policies and recommend changes on a case-by-case basis which will encourage water conservation.

General

The following pertain to all water use.

DWR will:

1. *encourage that all water pricing be based on costs except where public policy dictates otherwise;*
2. *conduct studies to identify specific areas of opportunities for water savings;*
3. *take legal action and encourage the State Water Resources Control Board to take actions to eliminate waste and non-beneficial use of water;*
4. *encourage the State Water Resources Control Board to require water conservation as a condition for approval of new water rights applications;*
5. *work with local agencies statewide to develop education programs to promote water conservation;*
6. *encourage and support research and demonstration of devices and methods for water conservation;*
7. *seek legislation to provide authority to water agencies to require water conservation actions as a condition of new service;*
8. *require water conservation as a condition for approval or support for loans and grants for water-related actions;*
9. *consider opportunities for water conservation in establishing priorities for use of the water supply;*
10. *reorient DWR planning programs to give major emphasis to water conservation;*
11. *in studies of possibilities for improving instream water uses, examine how increased efficiency of water use in the urban and agricultural sector may allow different water delivery system design and operation in order to leave more flows in certain stretches of our streams and rivers.*

CONVERSION FACTORS

English to Metric System of Measurement

Quantity	English unit	Multiply by	To get metric equivalent
Length	inches (in)	25.4	millimetres (mm)
		.0254	metres (m)
	feet (ft)	.3048	metres (m)
	miles (mi)	1.6093	kilometres (km)
Area	square inches (in^2)	6.4516×10^{-4}	square metres (m^2)
	square feet (ft^2)	.092903	square metres (m^2)
	acres	4046.9	square metres (m^2)
		.40469	hectares (ha)
		.40469	square hectometres (hm^2)
		.0040469	square kilometres (km^2)
	square miles (mi^2)	2.590	square kilometres (km^2)
Volume	gallons (gal)	3.7854	litres (l)
		.0037854	cubic metres (m^3)
	million gallons (10^6 gal)	3785.4	cubic metres (m^3)
	cubic feet (ft^3)	.028317	cubic metres (m^3)
	cubic yards (yd^3)	.76455	cubic metres (m^3)
	acre-feet (ac-ft)	1233.5	cubic metres (m^3)
		.0012335	cubic hectometres (hm^3)
		1.233×10^{-6}	cubic kilometres (km^3)
Volume/Time (Flow)	cubic feet per second (ft^3/s)	28.317	litres per second (l/s)
		.028317	cubic metres per second (m^3/s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
		6.309×10^{-5}	cubic metres per second (m^3/s)
	million gallons per day (mgd)	.043813	cubic metres per second (m^3/s)
Mass	pounds (lb)	.45359	kilograms (kg)
	tons (short, 2,000 lb)	.90718	tonne (t)
		907.18	kilograms (kg)
Power	horsepower (hp)	0.7460	kilowatts (kW)
Pressure	pounds per square inch (psi)	6894.8	pascal (Pa)
Temperature	Degrees Fahrenheit (°F)	$\frac{tF - 32}{1.8} = tC$	Degrees Celsius (°C)